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(54) METHOD FOR REPAIRING A COMBUSTION CHAMBER ASSEMBLY

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PROCEDE DE REPARATION D'UN ENSEMBLE CHAMBRE A COMBUSTION

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Description

Technical Field

This invention relates to a gas turbine engine and more particularly to a method for repairing a combustion chamber assembly for such an engine. The present invention was developed for use in the field of axial flow gas turbine engines.

Background

An axial flow gas turbine engine includes a compression section, a combustion section and a turbine section. The engine has a rotating rotor assembly. The rotor assembly includes a rotor disk-blade assembly which extends axially through the compression section, a rotor disk-blade assembly which extends axially through the turbine section, and a rotor shaft which extends axially connecting the rotor disk-blade assembly in the turbine section to the rotor disk-blade assembly in the compression section. A stationary stator assembly extends axially through the compression section and the turbine section of the engine. The stator assembly includes a case which circumscribes the rotor assemblies, supports which extend radially inwardly from the case for supporting the rotor assemblies, and stator vanes which extend radially inwardly from the case at a location upstream of each rotor assembly. The stator vanes prepare the gases for entry into the rotor disk-blade assembly.

A flow path for working medium gases extends axially through the sections of the engine. As the gases are flowed along the flow path, the gases are compressed in the compression section and burned with fuel in the pressurized combustion section to add energy to the gases. The gases flow to the turbine section where the rotor disk-blade assembly converts the energy in the gases into power to drive the compressor by turning the rotor shaft. The compressor and turbine sections have a special configuration, but only that of the combustion section is of interest here.

The combustion section includes a combustion chamber assembly extending circumferentially about an axis of symmetry. The combustion chamber assembly has an upstream end and a downstream end. The combustion chamber assembly includes an inner combustion chamber wall and an outer combustion chamber wall which extend between the ends. The walls are spaced radially leaving an annular combustion zone therebetween. A bulkhead assembly at the upstream end extends between the walls to join the walls together. The bulkhead assembly includes an inner ring, an outer ring and a bulkhead which extends between the two rings. The bulkhead is welded to the inner ring and outer ring to form an integral part.

The bulkhead has a first surface facing upstream and a second surface facing downstream. A dome-shaped hood for the combustion chamber extends over the upstream end of the combustion chamber assembly covering the first surface of the bulkhead. A plurality of lug mountings are an integral part of the hood and adapt the combustion chamber assembly for attachment in the engine. A plurality of openings are disposed circumferentially about the hood and the bulkhead. Each opening adapts the combustion chamber assembly to receive an associated fuel nozzle. Each fuel nozzle extends through the hood and the bulkhead for spraying fuel into the combustion chamber assembly.

A guide for each fuel nozzle is disposed in each opening in the bulkhead. The guides are spaced axially and spaced radially from the bulkhead leaving a passage for cooling air therebetween. A support, which is generally cylindrical in shape and extends upstream toward the combustion hood, is attached to the bulkhead and the guide to support the guide from the bulkhead. An anti-rotation element extends between each fuel nozzle and each support to restrain the fuel nozzle against rotation.

It is critical to the operative life of the engine that the angle of each fuel nozzle in relation to the lug mountings remains within predetermined limits. If the nozzle is positioned incorrectly, fuel may be sprayed onto the combustion chamber assembly walls, and the walls may be burned.

In addition, the original engine has a temperature profile in the circumferential direction and the radial direction for the gases entering the high pressure turbine. The temperature profile of the gases exiting the combustion section around the annular combustion chamber assembly must substantially match some predetermined temperature profile. Improper alignment of the fuel nozzles may cause the gases exiting the combustion section to have an altered temperature profile representing a temperature differential around the annulus, and/or the radius of the combustion chamber assembly. The gases exiting at a temperature profile substantially different than that of the original engine may excessively heat the rotor blades and the stator vanes in the turbine section causing the rotor blades and the stator vanes to oxidize and eventually fail.

Typically, a repaired combustion chamber assembly may have a substantial temperature differential in its profile. The temperature profile causes premature rotor blade and stator vane failure in the turbine section. There is a inverse relationship between the quality of the repair and the rate of premature failure. Thus, the proper maintenance and repair of the combustion chamber assembly is vital to the durability the combustion chamber assembly and the turbine, and ultimately the performance of the aircraft.

The combustion chamber assembly is typically repaired two to three times in its life. Repairs may be performed on the supports for the fuel nozzle guides, the anti-rotation elements which rest on the supports, the openings for the fuel nozzle guides on the bulkhead and

the walls of the combustion chamber assembly. Accessing the walls for repair requires that the inner wall be removed. Because the elements and areas on the bulkhead needing repair are directly beneath the hood of the combustion chamber assembly, the industry practice is to remove the hood from the combustion chamber assembly to gain access to these damaged elements and areas.

Removing the hood is normally done by utilizing a cutting apparatus and a holding apparatus. The first step is to mark an inside cut-line around the perimeter of the inner wall of the hood and to mark an outside cut-line around the perimeter of the outer wall of the hood. The next step is to place the combustion chamber assembly with the hood facing upwardly into the center of the cutting apparatus. Then the combustion chamber assembly is held firmly in place by the holding apparatus, a hydraulic sizing cluster.

The sizing cluster fits into the combustion chamber assembly and holds the combustion chamber assembly on the inner diameter of the combustion chamber hood at a position lower than the inside cut-line. The set up of the sizing cluster is time consuming and difficult, because using the sizing cluster requires working with many small parts. Once, the combustion chamber assembly is secure the cutting apparatus is used.

The cutting apparatus includes a crank arm, a fixed arm, an annular track and a cutting wheel. A gear system converts the rotary motion of turning the crank arm into the circumferential motion of the fixed arm traveling along the track. The cutting wheel is mounted on the end of the fixed arm. The cutting wheel is powered by an air system.

The cutting wheel is positioned along the inside cut-line and rotated as many revolutions around the combustion chamber assembly as is necessary to separate the metal surfaces along the inside cut-line. The cutting wheel is then positioned along the outside cut-line and rotated until the metal surfaces separate.

Despite the existence of such methods of repairing the combustion chamber assemblies, scientists and engineers working under the direction of applicants' assignee, are searching for methods of repairing the combustion chamber assembly in a way that prevents excessive shop repair and reassembly time and maintains the original temperature profile for the high turbine inlet.

SUMMARY OF INVENTION

This invention is in part predicated on recognizing the standard method of repairing a combustion chamber assembly in the gas turbine industry causes several problems. First, when the combustion chamber assembly is repaired it may need repairs to the outer combustion chamber wall, the bulkhead and the inner combustion chamber wall of the combustion chamber assembly.

The inner combustion chamber wall is normally riveted and is easily removed from the combustion chamber assembly leaving a hooded bulkhead portion of the combustion chamber assembly, which includes the outer combustion chamber wall and the bulkhead. The industry standard method leaves the outer wall and the bulkhead as one part, the hooded bulkhead portion of the combustion chamber assembly. The repairs to the walls and the bulkhead require special tools and training, so one shop within each repair department handles work on the walls and another shop handles repairs on the bulkhead. Repairs to the hooded bulkhead portion of the combustion chamber assembly must be done first by the shop that works on the outer wall then by the shop that works on the bulkhead. The standard method leads to a repair time for the hooded bulkhead portion of the combustion chamber assembly which is the sum of the repair times for the outer wall and the bulkhead.

Second, the combustion chamber hood is rigidly attached to the inner ring and the outer ring of the bulkhead assembly. This attachment along with inwardly extending flanges along the hood and excess support material make the hood a reinforcing element to the bulkhead assembly. Once the hood is removed, the bulkhead assembly is no longer rigid and the bulkhead assembly moves to a new angle in relation to the lug mountings. Fuel nozzles extend through the bulkhead; therefore, altering the bulkhead angle alters the critical relationship the fuel nozzles have with the lug mountings.

As mentioned earlier, improper alignment of the fuel nozzles may alter the temperature profile of the gases exiting the combustion chamber assembly and entering the high pressure turbine. The gases exiting at a temperature profile substantially different than that of the original engine may excessively heat the downstream array of stator vanes and rotor blades in the turbine causing destruction of the rotor blades and stator vanes. Using the standard method, the appropriate shop must attempt to manually correct the nozzle angle in reassembly

Next, the industry standard method, as mentioned in the Background Section, utilizes a cutting wheel. The cutting wheel causes a substantial gap at the cut-lines which is greater than or equal to sixty (60) thousandths of an inch in width. Reassembly requires tedious manual labor at a high cost due to the need to add filler material to the substantial gap, to blend smooth surfaces, to contour the hood and to perform excessive welding operations. Repairs performed utilizing the cutting wheel not only increase the reassembly time, but may also have graver consequences.

The excessive welding necessary after using the cutting wheel can lead to a large temperature differential on the annular combustion chamber assembly by disrupting the air flow in the combustion chamber assembly. When air flow is disrupted, the amount of cooling around the annular combustion chamber assembly varies and causes the temperature within the combustion chamber assembly to change. The temperature differ-

ential causes variations in the temperature profile for the high pressure turbine inlet that can lead to premature failure of the turbine rotor blades and stator vanes; therefore, repairing in the prior art fashion decreases engine durability and efficiency.

Lastly, integrated into the hood are a plurality of lug mountings, which are the datum for the combustion chamber assembly. This invention recognizes that shops that perform repairs with the prior art method of removing the hood will produce a combustion chamber assembly not having the same relationship to the engine as the original combustion chamber assembly.

According to the present invention, a method of repairing a combustion chamber assembly having an annular bulkhead and a combustion chamber hood (having integrated lug mountings extending from the hood), includes separating the annular bulkhead from the combustion chamber assembly, fixing the bulkhead as one part and fixing a remaining hooded portion of the combustion chamber assembly as a second part and then reattaching the bulkhead to the hooded portion of the combustion chamber assembly.

In accordance with one embodiment of the present invention, the bulkhead is separated to allow repairs of the bulkhead and the hooded portion of the combustion chamber assembly to proceed at the same time rather than in series.

According to the present invention, a method of repairing a hooded bulkhead portion of the combustion chamber assembly of a gas turbine engine includes the steps of supporting the hooded bulkhead portion of the combustion chamber assembly on a repair apparatus; separating the hooded bulkhead portion of the combustion chamber assembly into at least two separate parts - a bulkhead and a hooded portion of the combustion chamber assembly; fixing the bulkhead and the hooded portion of the combustion chamber assembly independently; reattaching the bulkhead to the hooded portion of the combustion chamber assembly.

A primary feature of the present invention is a method, which includes gaining access to the damaged areas on or near the bulkhead by separating the bulkhead from the combustion chamber assembly. A feature of one embodiment of the invention is separating the bulkhead utilizing a laser cutting system. Another feature is positioning the portions of the combustion chamber assembly and the bulkhead utilizing the repair apparatus.

A principal advantage of the present invention is the speed of repairing a combustion chamber assembly which results from removing the bulkhead by allowing processing of the bulkhead and the hooded portion of the combustion chamber assembly to proceed independently. Another advantage is the durability and efficiency of a gas turbine engine employing a repaired combustion chamber assembly, which results from avoiding hood removal and avoiding use of the cutting wheel, thus maintaining the original temperature profile for the high turbine inlet around the annulus of the combustion chamber assembly. Yet another advantage is the speed and ease of reassembly which results from removing the bulkhead, by avoiding difficult manual alignment of the fuel nozzle angles. Speed and ease of reassembly also results from removing material with the laser system by allowing hand and possibly automated welding operations, and by avoiding substantial material loss, thus avoiding the need to fill a substantial gap and sand surfaces smooth. Still another advantage is allowing the repaired combustion chamber assembly to have the same relationship with the engine, which results from avoiding removal of the hood.

The foregoing features and advantages of the present invention will become more apparent in the light of the following detailed description of the best mode for carrying out the invention and in the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

Fig. **1** is a perspective view of a gas turbine engine mounted on an aircraft wing broken away to show interior portions of a combustion section and a turbine section.

Fig. **2** is a perspective view in full of a combustion chamber assembly in an uninstalled condition.

Fig. **3** is an end view of the combustion chamber assembly partially broken away to show a fuel nozzle and a combustion chamber hood with interior portions of a bulkhead shown.

Fig. **4** is an enlarged side elevation view taken along the line **4-4** of the Fig. **3** showing the combustion chamber assembly as it appears during a repair operation after removal of an inner combustion chamber wall.

Fig. **5** is a cross-sectional view taken along the line **5-5** of Fig. **6** showing a cross-section of a bulkhead assembly.

Fig. **6** is a side elevation view of a hooded bulkhead portion of the combustion chamber assembly with interior portions of the combustion chamber assembly broken away and shown as they appear during the repair operation.

Fig. **7** is a cross-sectional view taken along line **7-7** of Fig. **6** showing a support assembly as it appears during the repair operation and the relationship between some of the elements of the support assembly that were discussed in Fig. **6**.

Fig. **8** is a side elevation view of the combustion chamber assembly as it appears during a procedure for reassembly of a bulkhead to a hooded portion of the combustion chamber assembly.

BEST MODE FOR CARRYING OUT THE INVENTION

Fig. **1** is a perspective view of a gas turbine engine **20** mounted on an aircraft wing. The engine includes a compression section **22**, a combustion section **24** and a turbine section **26**. An annular flow path **28** for working

medium gases extends axially through these sections of the engine. An engine case **30** extends axially through the engine to bound the flow path.

The engine case **30** is partially broken away to show a portion of the combustion section **24** and the turbine section **26**. The combustion section includes a combustion chamber assembly **32** and a plurality of fuel nozzles, as represented by the single fuel nozzle **34**. The turbine section includes an array of stator vanes, as represented by the stator vane **36**. The vanes extend radially across the flow path for gases at a location downstream of the combustion chamber. An array of rotor blades (not shown) are downstream of the combustion chamber assembly and extend radially at a location downstream of the array of stator vanes.

Fig. **2** is a perspective view in full of the combustion chamber assembly **32** in an uninstalled condition. The combustion chamber assembly has an upstream end **38** and a downstream end **40**. The combustion chamber assembly has an inner combustion chamber wall **42** and an outer combustion chamber wall **44** which extend between the ends. The walls are capped by a combustion chamber hood **46**. A plurality of openings **47** are disposed circumferentially about the hood. A bulkhead assembly (not shown) extends between the walls and lies directly beneath the hood. A plurality of lug mountings **48** are an integral part of the hood.

Fig. **3** is an end view of the combustion chamber assembly **32**. The combustion chamber assembly and the engine case **30** are partially broken away for clarity. The plurality of lug mountings, as represented by the lug mounting **48**, extend from the combustion chamber assembly and each lug mounting is adapted to be attached to the engine case. In the embodiment shown, a pin **50** engages the case and the lug mounting and a bushing **52** protects the lug mounting from wear. The plurality of fuel nozzles **34** extend through the combustion chamber hood **46** and the bulkhead assembly **54** at a predetermined angle to spray fuel into the combustion chamber assembly.

Fig. **4** is an enlarged side elevation view of a portion of the combustion chamber assembly **32a**. The combustion chamber assembly has an axis of symmetry **A**. Fig. **4** shows the combustion chamber assembly as it appears during a repair operation after removal of the inner combustion chamber wall **42** (shown in phantom). Once the inner wall is removed, the remainder of the combustion chamber assembly forms the hooded bulkhead portion of the combustion chamber assembly **32a**. The inner wall is integrally attached to the combustion chamber assembly, such as by rivets. The outer combustion chamber wall **44** is attached by welding.

The bulkhead assembly **54** extends between the two walls. The bulkhead assembly includes an inner ring **56**, an outer ring **57** and a bulkhead **58** which extends between the two rings. The inner ring of the bulkhead assembly has an inner surface **59**. The inner wall is riveted to the inner surface of the inner ring. The bulkhead has a first surface **60** which faces the upstream end **38** of the combustion chamber assembly. The combustion chamber hood **46** covers the first surface of the bulkhead. The plurality of lug mountings, as represented by the lug mounting **48**, are an integral part of the hood.

The plurality of openings, as represented by the opening **47**, are disposed circumferentially about the hood **46**. A plurality of openings, as represented by the opening **62**, are disposed circumferentially about the bulkhead. Each opening adapts the combustion chamber assembly to receive an associated fuel nozzle **34**, which in this Fig. is broken away for clarity. Each fuel nozzle extends through the hood and the bulkhead for spraying fuel into the combustion chamber assembly.

A plurality of guides, as represented by the guide **64** (shown in phantom), are each disposed in each opening **62** in the bulkhead **58**. The guides are spaced axially and spaced radially from the bulkhead leaving a passage for cooling air **66** therebetween. A flow path **67** for cooling air extends through the passage. A plurality of supports, as represented by the support **68**, are attached to the first surface **60** of the bulkhead and the guide. The supports join the guides to the bulkhead. The supports extend toward the upstream end **38** of the combustion chamber assembly and the hood **46**. The combustion chamber assembly may include other elements which are not shown, such as, a plurality of anti-rotation elements extending between each fuel nozzle and each support to restrain the fuel nozzle against rotation.

The combustion chamber assembly has a reference plane **B** which is defined by three points, where each of the three points is at the same relative location on a separate lug mounting **48**. A centerline **C** for the opening **62** for the fuel nozzle shows the orientation of the fuel nozzle with respect to the reference plane **B**. A reference line **A'** is a line parallel to the axis of symmetry **A** and intersects the line **C**.

A radial reference plane **P** contains the axis **A** and the line **C**. The plane **P** intersects the bulkhead **58** at a reference line **L**. The plane **P** intersects the plane **B** at a reference line B_L.

An angle between the reference line **L** and the reference line B_L is the angle of the bulkhead (bulkhead angle) with respect to the reference plane **B** for the combustion chamber assembly. It is also equal to an angle a between the line **C** and the line **A'**. Therefore, the bulkhead angle represents the angle of the bulkhead in relation to the lug mountings. The bulkhead angle **a** in the originally manufactured combustion chamber assembly is precisely determined and in the embodiment shown measures about fifteen degrees (15°).

An inner separation region **70** and an outer separation region **72** extend circumferentially about the bulkhead. The separation regions are commonly referred to as the cut-lines. In the prior art repair method an inside cut-line **74** and an outside cut-line **76** were used.

Fig. **5** is a cross-sectional view of the bulkhead assembly **54** taken along line **5-5** of Fig. **6**. The bulkhead

assembly includes the inner ring **56** and the outer ring **57** joined by the bulkhead **58**. The plurality of openings **62** for the fuel nozzles are disposed on the bulkhead. The bulkhead is separated along an inner circumference of the bulkhead at the cut-line **70**, and along an outer circumference at the cut-line **72**. Prior to separating the bulkhead, several reference lines **73** ere drawn from the inner ring onto the bulkhead and the from the outer ring onto the bulkhead with a predetermined relationship to one another which assures the bulkhead is retumed to the same circumferential position from which it was removed.

Fig. **6** is a side elevation view of the hooded bulkhead portion of the combustion chamber assembly **32a** as it appears during a repair operation. A repair apparatus **78** for rotating and supporting the hooded bulkhead portion of the combustion chamber assembly engages the lug mountings **48** of the hooded bulkhead portion of the combustion chamber assembly. The repair operations occur about the axis of symmetry **A** of the combustion chamber assembly. A laser beam **80** is positioned within the combustion chamber assembly for cutting around the bulkhead **58**.

The repair apparatus **78** includes a support assembly **82** and a rotator assembly **84**. In the embodiment shown the support assembly includes a steel base plate **86**, means for indexing the bulkhead **88** and an aluminum center plate member **90**. In other embodiments, the support assembly may include the base plate and the means for indexing the bulkhead, where the center plate member has become an integral part of the base plate.

The bese plate **86** includes a center opening **92** which adapts the base plate for rotation about the axis of symmetry **A**. The base plate has an outer rim **94** which extends upwardly from the base plate and circumferentially about the base plate. A plurality of pin holes, as represented by the pin hole **96**, extend through the outer rim of the base plate. A plurality of locating pins, as represented by the locating pin **98**, extend through the pin holes. A cavity **100** between the outer rim of the base plate and the means for indexing the bulkhead **88** receives the lug mountings (not shown). The lug mountings are engaged by the locating pins.

The means for indexing the bulkhead **88** includes an indexing plate **102** which attaches to the base plate **86**. The indexing plate has a center hole **104** which adapts the plate for inserting of a locating cylinder **105** through the indexing plate. In other embodiments, the indexing plate is rigidly attached to the base plate, such as by bolts, and by virtue of this rigid attachment the indexing plate is centered on the rotator assembly. A plurality of plug holes as represented by the plug hole **106**, shown by the dotted lines, are disposed around the circumference of the indexing plate. A plurality of plugs, shown in Fig. **8**, engage the plug holes of the indexing plate.

The center plate member **90** includes locating surfaces **108** which engage the base plate **86** in the base plate center opening **92**. The center plate member has a center hole **110** for receiving the locating cylinder **105**.

The support assembly has bolt holes (not shown) for rigidly attaching the support assembly to the rotator assembly **84**. The rotator assembly includes the means for causing the relative rotation of the support assembly with respect to the laser system **80**, such as a turn table **112**. The turn table has a center hole **114** for receiving the locating cylinder **105**.

A cutting device, such as a laser beam **80**, may be placed within the hooded bulkhead portion of the combustion chamber assembly **32a**. The laser nozzle assembly **116** may be positioned near the bulkhead **58**. The laser nozzle assembly includes a lens (not shown). A dial indicator **118** is disposed adjacent to the hooded bulkhead portion of the combustion chamber assembly. The dial indicator is connected to a fixed support, as represented by the dial indicator connected to a laser system **119** by a magnet. The dial indicator picks up on the inner surface **59** of the inner ring **56** of the bulkhead assembly **54**.

Fig. **7** is a cross-sectional view taken along line **7-7** of Fig. **6** showing a support essembly **82** as it appears during a repair operation and the relationship between some of the elements of the support assembly that were discussed in Fig. **6**. The support assembly holds the combustion chamber assembly **32** (not shown) in position. In the embodiment shown the support assembly includes the steel base plate **86**, the means for indexing the bulkhead **88** and the center plate member **90**.

The base plate **86** includes the center opening **92** which edapts the base plate for rotation about the axis of symmetry **A** of the combustion chamber assembly. The outer rim **94** extends upwardly from the base plate and circumferentially about the base plate. The pin holes **96** extend through the outer rim of the base plate. The locating pins **98** extend radially inwardly through the pin holes and have the relationship illustrated. The cavity **100** between the outer rim of the base plate and the means for indexing the bulkhead **88** receives the lug mountings **48**. The lug mountings are engaged by the locating pins.

The means for indexing the bulkhead **88** includes the indexing plate **102** which attaches to the base plate **86** . The plug holes **106** are disposed circumferentially about the indexing plate.

The base plate **86** and the indexing plate **102** of the support assembly each have a plurality of lifting holes **120** disposed circumferentially about the two plates. The base plate and the indexing plate of the support assembly have bolt holes (not shown) for rigidly attaching the support assembly to the rotator assembly (not shown).

The center plate member **90** engages the base plate **86** in the center opening **92** of the base plate.

The hole in the center of the support assembly extends through the center plate member **90** and the indexing plate **102** for receiving the locating cylinder (not

shown).

Fig. **8** is a side elevation view of a combustion chamber assembly **32b**. Fig. **8** shows the combustion chamber assembly as it appears during a procedure for reattaching the bulkhead **58** to the hooded portion of the combustion chamber assembly **32b**. Once the inner wall **42** and the bulkhead are removed, the remainder of the combustion chamber assembly forms the hooded portion of the combustion chamber assembly. Fig. **8** also clarifies the features of some of the elements of the support assembly of the repair apparatus that were discussed in Fig. **6,7**.

The repair apparatus **78** supports the hooded portion of the combustion chamber assembly **32b**. The repair apparatus includes the support assembly **82**, the rotator assembly (not shown), the locating cylinder **105** and a bung plate **122**. In the embodiment shown the support assembly includes the base plate **86**, the means for indexing the bulkhead **88** and the center plate member **90**.

As mentioned earlier, the means for indexing the bulkhead **88** has the plug holes **106** disposed around the circumference. Each plug hole has an angle parallel with the original bulkhead angle **a**, for orienting the bulkhead and a depth **d** for aligning the bulkhead with the surface adjacent to the inner ring **56** which remained attached to the combustion chamber assembly **32**. The plugs **124** engage the plug holes for orienting and aligning the bulkhead in the reassembly of the combustion chamber assembly. Each plug has a hand knob **126** which extends outwardly from the plug to allow for the removal of the plug. Alternatively, any projection which allows for the removal of the plug would suffice.

The aluminum bung plate **122** has a surface **128** having a diameter which locates on the inner surface **59** of the inner ring **56** adjacent to the bulkhead **58** position. The bung has several holes (not shown) disposed around the circumference of the bung plate for a device for inserting and removing the bung plate from the combustion chamber assembly.

During operation of the gas turbine engine **20**, shown in Fig. **1**, gases are flowed along the flow path **28**. As the gases are flowed along the flow path, the gases are compressed in the compression section **22** and burned with fuel in the pressurized combustion section **24** to add energy to the gases. The gases are flowed to the turbine section **26**. The turbine section converts the energy in the gases into work and thrust.

The combustion section **24** includes the combustion chamber assembly **32**. During the operation of the engine, the combustion chamber assembly is bathed in hot gases. These gases flowed through the combustion chamber assembly cause distress and cracking of parts of the combustion chamber assembly walls **42,44**. The distress and cracking are due to forces exerted on the combustion chamber assembly and temperature cycles that accompany the operative conditions of the engine. As shown in Fig. **4**, The fuel nozzle guides **64** are each welded to an associated support **68**. Cooling air is flowed along the flow path **67**. The flow path for cooling air extends through a cooling air passage **66**. The axial spacing through which the cooling passage extends decreases due to the forces and temperature cycles that occur during operation of the engine and the cooling air is subsequently cut off. As a result, the fuel nozzle guides must be replaced and any damage to the bulkhead must be repaired.

In addition, the movement of parts associated with the fuel nozzle **34**, such as the anti-rotation elements, on the fuel nozzle guide support **68**, during engine use causes wear on the anti-rotation element, such that the anti-rotation element may be replaced, and wear such that the support may be repaired. The present invention focuses on a method of repairing the combustion chamber assembly.

Typically, the combustion chamber assembly **32** will come to a repair department without the fuel nozzle guides **64** and the inner combustion chamber wall **42**. If the fuel nozzle guides are present, they are machined off the bulkhead **58**. If the inner wall **42** is in place, the rivets holding the inner wall are machined off and the inner wall is removed. The remainder of the combustion chamber assembly is referred to as the hooded bulkhead portion of the combustion chamber assembly **32a**.

The present invention is a method for repairing the hooded bulkhead portion of the combustion chamber assembly **32a** and includes the following steps. As shown in Fig. **6**, the first step is to support the hooded bulkhead portion of the combustion chamber assembly on the repair apparatus **78**. This step includes centering the center plate member **90** on the means for rotating the combustion chamber assembly, such as a turn table **112**, by placing the center plate member on the turn table and extending the locating cylinder **105** through the center plate member and the hole **114** in the turn table.

Then, the base plate **86** with the means for indexing **88** attached is centered on the center plate member **90** by placing the base plate on the center plate member and extending the locating cylinder **105** through the indexing plate **102**, the center plate member **90** and the turn table **112**.

The next step is to center the hooded bulkhead portion of the combustion chamber assembly **32a** on the support assembly **82**. This includes the steps of engaging the lug mountings **48** with the locating pins **98** and adjusting the location of the hooded bulkhead portion of the combustion chamber assembly on the support assembly until it is concentric with the support assembly. The locating pins and the dial indicator **118** are utilized. The dial indicator is disposed adjacent to the hooded bulkhead portion of the combustion chamber assembly on a fixed support, such as the laser system **119**, and runs on the inner surface **59** of the inner ring **56** of the bulkhead assembly **54**.

The next step is to separate the hooded bulkhead portion of the combustion chamber assembly **32a** into

at least two separate elements, one of which is the bulkhead **58**. Separating the bulkhead **58** includes the steps of causing two separations by making a separation cut on the bulkhead at an inner cut-line **70** and an outer cut-line **72**. Using a laser beam **80** results in a separation cut of between about 0.1524 mm [six (6) thousandths of an inch] in width to about 0.3032 mm [eight (8) thousandths of an inch] in width. Other embodiments may employ, for example, a water-jet having a separation cut of about 0.762 to 1.016 mm [thirty (30) thousandths to fourty (40) thousandths of an inch] in width or a plasma cutting system having a separation cut of about 0.4064 mm [sixteen (16) thousandths of an inch] in width.

As shown in Fig. **5**, the steps for causing the separation include marking the reference lines **73** on the bulkhead **58**, the inner ring **56** and the outer ring **57** of the bulkhead assembly **54**. As shown in Fig. **6**, the laser beam **80** (Lumonics Corporation Laserdyne Model #780) is positioned for removing material along the inner separation area and the outer separation area on the bulkhead utilizing the cut-lines **70** and **72** respectively. The laser operates at a speed that is dependent on the material thickness of the bulkhead and a power setting that penetrates through the bulkhead material and avoids thermal distortions of adjacent surfaces or destructive exit damage to the hood **46**. The laser is particularly adapted for this function.

The laser nozzle assembly **116** has a lens which focuses the energy from the laser beam so that the maximum energy discharge occurs at the bulkhead and the energy dissipates at locations beneath the bulkhead. Thus, after removing material through a rotation of three hundred and sixty (360) degrees along the inner separation area and the outer separation area the laser beam does not remove material from the hood or other structures. In addition the focal point of the laser beam coupled with the minimal heat discharged from the laser beam allows surfaces adjacent to the separation regions to experience minimal thermal distortions.

It is vital when utilizing the repair apparatus **78** which supports the combustion chamber assembly by the lug mountings **48** that during the cutting operation the transverse forces on the lug mountings are minimal and the resultant forces on the lug mountings put the lug mountings in compression. As discussed earlier, the lug mountings are weak in shear. Thus, the lug mountings may be unable to oppose the transverse forces of the cutting device and as a result the lug mountings may snap during a circumferential cutting operation. However, the laser beam imparts minimal transverse forces on the combustion chamber assembly during the circumferential cutting operation, so the lug mountings may not break.

In addition, the repair apparatus must hold the combustion chamber assembly securely during the cutting operation. Unlike the cutting wheel, the laser imparts minimal forces in the form of stress and vibration so the repair apparatus holds the combustion chamber securely. These forces do not make the combustion chamber assembly so unsteady on the repair apparatus that cutting is not possible.

Other embodiments of the present invention may utilize a variety of cutting devices other than the laser. One such device is the hand held air grinding apparatus with a cutting wheel. This is the conventional tool used to remove the hood in the prior art method and may be utilized here. Also, burrs may be utilized with the cutting wheel to improve this embodiment. Another device is a water-jet cutting system, with an abrasive agent in the water if necessary to cause the separation between cut surfaces. Some substance, such as foam, must be interposed between the jet and the hood in order to prevent the jet from causing destructive exit damage to the hood. Another possibility is a plasma cutting system that can be likened to a refined torch; however, some substance must be interposed between the plasma cutting system and the hood in order to prevent destructive exit damage to the hood. Another possibility is an electrical discharge machining device that utilizes an electrode to make the separations . Also, a lathe with a single point parting tool or a milling machine with a conventional milling cutter may be used. The term "cutting device," encompasses not only these embodiments, but includes any device which could make the cut without damaging the hood, the adjacent surfaces or the lug mountings while the repair apparatus is able to hold the combustion chamber assembly securely.

Once separating is complete, the next step is to repair the bulkhead **58** and the hooded portion of the combustion chamber assembly **32b** independently. This step includes removing the bulkhead from the hooded bulkhead portion of the combustion chamber assembly **32a**, removing the remaining hooded portion of the combustion chamber assembly from the repair apparatus **78**, and repairing the bulkhead and the hooded portion of the combustion chamber assembly as necessary by the required specialists. Typically repair of these parts includes refurbishing any of the following the anti-rotation elements, the supports **68** for the fuel nozzle guides **64**, the bulkhead **58** the outer wall **44** or any other item which requires repair.

As shown in Fig. **8**, the last step is to reattach the bulkhead **58** to the hooded portion of the combustion chamber assembly **32b** which includes the following steps. First, the hooded portion of the combustion chamber assembly is supported on the repair apparatus **78** by engaging the locating pins **98**. The bulkhead **58** is positioned flush with the portion of the bulkhead surface on the hooded portion of the combustion chamber assembly utilizing the reference lines **73** and the plugs **124**. The bung plate **122** is forcefully disposed inside the hooded portion of the combustion chamber assembly adjacent to the inner surface **59** of the inner ring **56** of the bulkhead assembly **54**. The bung plate is located to maintain the circular shape of the inner diameter of the combustion chamber assembly **32** and the concentricity

of the combustion chamber assembly during the repair operation. Copper chill plates are inserted in the openings **62** for the fuel nozzles **34**. The next steps are tack welding along the inner circumference of the cut surface of the bulkhead then tack welding along the outer circumference of the cut surface of the bulkhead.

The order of many of the steps is not significant. One exception is the order of the tack welding steps. Each of the two cut surfaces of the bulkhead must be joined to a corresponding surface attached to the hooded portion of the combustion chamber assembly **32b**. The inner circumference of the bulkhead is attached adjacent to the inner ring **56** and the outer circumference of the bulkhead is attached adjacent to the outer ring **57** of the bulkhead assembly **54**. If welding of the outer circumference were to take place before welding of the inner circumference, the inner edge of the bulkhead would drop below the adjacent surface of the hooded portion of the combustion chamber assembly due to distortions of the bulkhead that accompany welding. Welding the inner circumference after welding the outer circumference would require a welder to simultaneously lift up the bulkhead, so the inner circumference is flush with the adjacent surface, and weld. Holding up the bulkhead and welding is difficult. When the inner circumference is welded first, the outer circumference distorts in a manner such that the outer edge of the bulkhead raises above the adjacent surface of the hooded portion of the combustion chamber assembly. Welding the outer circumference after welding the inner circumference would require the welder to simultaneously hold down the bulkhead, so the outer circumference is flush with the adjacent surface, and weld. Holding down the bulkhead and welding is relatively easy. Accordingly, tack welding should proceed from the inner circumference to the outer circumference.

The welding need not be completely finished at the inner circumference before proceeding to the outer circumference. Good results were obtained by providing a tack welds about 6.35 mm [one-quarter (0.25) of an inch] to about 12.7 mm [one-half (0.50) of an inch] apart around the inner circumference. Then providing tack welds about 6.35 mm [one-quarter (0.25) of an inch] to about 12.7 mm [one-half (0.50) of an inch] apart around the outer circumference. The following steps are to weld about 101.6 to 152.4 mm [four (4) inch to six (6) inch] strips around the inner circumference at staggered locations and to weld the remainder of the inner circumference. Only the remainder of the inner circumference need be welded since the staggered weld strips are quality welds of the appropriate penetration. The remaining steps are to weld about 101.6 to 152.4 mm [four (4) inch to six (6) inch] strips around the outer circumference at staggered locations and to weld the remainder of the outer circumference. Only the remainder of the outer circumference need be welded since the staggered weld strips are quality welds of the appropriate penetration. Although the plugs **124** allow the bulkhead angle **a**, as shown in Fig. 4, to be roughly correct welding distorts the angle somewhat. Because this angle is so critical to the life of the engine, the next step is to mechanically manipulate the combustion chamber assembly **32** to restore the original bulkhead angle **a**.

The step of manipulating the combustion chamber assembly **32** to restore the bulkhead angle **a** is an independent operation. The combustion chamber assembly is removed from the repair apparatus **78** and placed on a hydraulic cylinder and ram. A plate having a contour, such that the edges are chamfered and polished smooth so that the plate fits into the inner diameter of the combustion chamber assembly, is placed inside the combustion chamber assembly and pulled downward until the relationship between the bulkhead and the lug mountings, as represented by the bulkhead angle **a**, is restored.

The present invention has several advantages over the prior art method of repair. During the repair process the hooded bulkhead portion of the combustion chamber assembly **32a** may need repairs to the outer combustion chamber wall **44** and the bulkhead **58**. A principal advantage of the present invention is the speed of repairing the hooded bulkhead portion of the combustion chamber assembly which results from removing the bulkhead by allowing processing of the bulkhead as one part and processing of the outer wall as a second part. Each of these repairs which require special tools and training and a different shop within each repair department is able to handle work on either part at the same time. The industry standard method leaves the outer wall and bulkhead as one part, so repairs must be done first by the shop that works on the outer wall then by the shop that works on the bulkhead; therefore, it leads to a repair time that is the sum of the repair times for the bulkhead and the outer wall. Thus, with the present invention the repair time decreases from the sum repair times for each part to the time for the longest repair time between the bulkhead and the outer wall.

Another advantage is the durability and efficiency of a gas turbine engine **20** employing the repaired combustion chamber assembly **32**, which results from avoiding hood **46** removal and utilizing the laser, thus maintaining the original temperature profile of the high turbine inlet around the annulus of the combustion chamber assembly. The hood is a reinforcing element to the bulkhead **58**, which maintains the angle that the bulkhead makes in relation to the lug mountings **48**, this angle is equal to the bulkhead angle **a**. By not removing the hood the present invention employs the hood to rigidly support the bulkhead and restrain the bulkhead from moving to a new angle. As shown in Fig. 3, the fuel nozzles **34** extend through the hood and the bulkhead; therefore, altering the bulkhead angle **a**, alters the fuel nozzle angle.

Recall, it is critical to the engine life that the angle of each fuel nozzle in relation to the bulkhead remains within predetermined limits, because misalignment can

lead to damage of the combustion chamber assembly walls **42,44** or the rotor blades or stator vanes **36** in the turbine section **26**. An advantage of the present invention is that the bulkhead angle **a** and the fuel nozzle angle are unaltered by the process, thus by maintaining the original temperature profile for the high turbine inlet around the annulus of the combustion chamber assembly the efficiency of the engine is maintained.

Utilizing the laser beam **80** results in minimal material loss; therefore avoiding excessive welding operations. The excessive welding can lead to a large temperature differential on the combustion chamber annulus that causes premature failure of the rotor blades and stator vanes **36** in the turbine section **26**. So, repairing by the present invention may not decrease the engine durability and efficiency.

Yet another advantage is allowing the repaired combustion chamber assembly **32** to have the same relationship with the engine as the original combustion chamber assembly which results from avoiding removal of the hood **46** and the lug mountings **48**. Integrated into the hood are the lug mountings, which are the datum for the combustion chamber assembly. The present invention avoids removal of the hood and allows shops to perform repairs with the original reference points of the piece. Thus, the repaired combustion chamber assembly will have the same relationship with the engine as the original combustion chamber assembly.

Still another advantage is the speed and ease of reassembly which results from removing the bulkhead, by avoiding difficult manual alignment of the fuel nozzle angles and which results from removing material with a laser beam **80** by allowing hand and possibly automated welding operations, and by avoiding substantial material loss.

Claims

1. A method of repairing a hooded bulkhead portion of a combustion chamber assembly of the type having an upstream end (38), a downstream end (40), an axis of symmetry A, a bulkhead assembly (54) which includes an inner ring (56), an outer ring (57) spaced radially from the inner ring (56), and an annular bulkhead (58) extending from the inner ring (56) to the outer ring (57), the bulkhead (58) having a number of openings (62) for orienting fuel nozzles (34) disposed circumferentially about the bulkhead (58), the combustion chamber assembly (32a) further including an outer wall (44) extending downstream from the outer ring (57) and a combustion chamber hood (46) extending upstream from the outer ring (57), then radially inwardly then downstream to the inner ring (56), the combustion chamber hood (46) having integrated lug mountings (48) extending therefrom upstream for supporting the combustion chamber assembly (32a) in the installed condition, comprising:

   (a) separating the annular bulkhead (58) by removing a circumferentially extending portion of material on the bulkhead (58) at a region between the openings (62) for the fuel nozzles (34) and the inner ring (56) and by removing a circumferentially extending portion of material on the bulkhead (58) at a region between the openings (62) for the fuel nozzles (34) and the outer ring (57); and
   (b) fixing the bulkhead (58) as one part and a hooded portion of the combustion chamber assembly (32a) as a separate part;
   (c) reattaching the bulkhead (58) to the hooded portion of the combustion chamber assembly (32a).

   wherein removing the bulkhead (58) from between the inner ring (56) and the outer ring (57) preserves the relationship the lug mountings (48) have with the inner ring (56) and the outer ring (57) of the bulkhead assembly (54),

   wherein leaving the combustion chamber hood (46) undisturbed allows the combustion chamber hood (46) to reinforce the inner ring (56) and the outer ring (57) and aids in maintaining the original orientation with respect to the lug mountings (48) during the repair operation.

2. The method of repairing a hooded bulkhead portion of the combustion chamber assembly of claim 1, wherein the step of separating the bulkhead (58) further includes the step of withdrawing the bulkhead (58) without disturbing the position of the inner ring (56) with respect to the lug mountings (48) and without disturbing the position of the outer ring (57) with respect to the lug mountings (48).

3. The method of repairing a hooded bulkhead portion of the combustion chamber assembly of claim 1, wherein the method employs a cutting device (80) and a repair apparatus (78) for supporting and positioning the combustion chamber assembly (32a) with respect to the cutting device the step of separating the bulkhead (58) further includes the steps of:

   (a) positioning the combustion chamber assembly (32a) on the repair apparatus (78); and
   (b) causing relative rotation between the cutting device (80) and the hooded bulkhead portion of the combustion chamber assembly (32a).

4. The method of repairing a hooded bulkhead portion of the combustion chamber assembly of claim 3, wherein the step of causing relative rotation between the cutting device (80) and the hooded bulk-

head portion of the combustion chamber assembly (32a) takes place about an axis of rotation (A) and further includes the step of maintaining the concentricity of the bulkhead (58) with respect to an axis of rotation coinciding with the axis of symmetry A of the hooded bulkhead portion of the combustion chamber assembly (32a).

5. The method of repairing a hooded bulkhead portion of the combustion chamber assembly of claim 1, wherein the step of separating the annular bulkhead (58) by removing a circumferentially extending portion of material on the bulkhead (58) at a region between the openings (62) for the fuel nozzles (34) and the inner ring (56) and by removing a circumferentially extending portion of material on the bulkhead (58) at a region between the openings (62) for the fuel nozzles (34) and the outer ring (57) further includes the step of removing less than about 1.016 mm [fourty (40) thousandths of an inch] in width of material at the separation regions.

6. The method of repairing a hooded bulkhead portion of the combustion chamber assembly of claim 5, wherein the step of removing less than about 1.016 mm [fourty (40) thousandths of an inch] in width of material at the separation regions further includes the step of positioning the hooded bulkhead portion of the combustion chamber assembly (32a) for passing the hooded bulkhead portion of the combustion chamber assembly (32a) through a laser beam (80).

7. The method of repairing a hooded bulkhead portion of the combustion chamber assembly of claim 1, wherein the step of separating the annular bulkhead (58) by removing a circumferentially extending portion of material on the bulkhead (58) at a region between the openings (62) for the fuel nozzles (34) and the inner ring (56) and by removing a circumferentially extending portion of material on the bulkhead (58) at a region between the openings (62) for the fuel nozzles (34) and the outer ring (57) further includes the step of positioning the hooded bulkhead portion of the combustion chamber assembly (32a) with respect to a laser beam (80) for passing the hooded bulkhead portion of the combustion chamber assembly (32a) through the laser beam.

8. The method of repairing a hooded bulkhead portion of the combustion chamber assembly of claim 1, wherein the step of separating the bulkhead further includes the steps of removing a circumferentially extending portion of material on the bulkhead (58) at a region in close proximity to the inner ring (56) and removing a circumferentially extending portion of material on the bulkhead (58) at a region in close proximity to the outer ring (57).

9. The method of repairing a hooded bulkhead portion of the combustion chamber assembly of claim 8, wherein the steps of removing material at two circumferentially extending regions further includes the steps of removing a circumferentially extending portion of material on the bulkhead (58) at a region coincident with the previous weld joint adjacent to the inner ring (56) and by removing a circumferentially extending portion of material on the bulkhead (58) at a region coincident with the previous weld joint adjacent to the outer ring (57).

10. The method of repairing a hooded bulkhead portion of the combustion chamber assembly of claim 1, wherein the step of fixing the bulkhead (58) as one part and the hooded portion of the combustion chamber assembly (32a) as a separate part further includes the step of restoring the bulkhead (58) and the hooded portion of the combustion chamber assembly (32a) during time periods which partly coincide.

11. The method of repairing a hooded bulkhead portion of the combustion chamber assembly of claim 1, wherein the step of reattaching the bulkhead (58) to the hooded portion of the combustion chamber assembly (32a) further includes the step of positioning the bulkhead (58) with respect to the hooded portion of the combustion chamber assembly (32a) which further includes the steps of axially locating the bulkhead (58) with respect to the inner ring (56) and the outer ring (57) and circumferentially locating the bulkhead (58) with respect to the lug mountings (48).

12. The method of repairing a hooded bulkhead portion of the combustion chamber assembly of claim 11, wherein the step of positioning the bulkhead (58) further includes the step of orienting the bulkhead (58) so that the angle (a) of the bulkhead (58) with respect to a reference plane defined by the lug mountings (48) is within predetermined limits established for a newly manufactured combustion chamber assembly.

13. The method of repairing a hooded bulkhead portion of the combustion chamber assembly of claim 1, wherein the step of reattaching the bulkhead (58) to the hooded portion of the combustion chamber assembly (32a) further includes the step of disposing a bung plate (122) within the hooded portion of the combustion chamber assembly (32a) to minimize the distortion the bulkhead (58) experiences during reassembly and to maintain the concentricity of the inner ring (56) of the bulkhead assembly (54).

14. A method for repairing a hooded bulkhead portion of a combustion chamber assembly of claim 1, com-

prising:

(a) supporting the hooded bulkhead portion of the combustion chamber assembly (32a) on a repair apparatus (78) of the type having a support assembly (82) having a base plate (86) which adapts for receiving a center plate member (90), locating pins (98) which extend radially, a means for indexing the bulkhead (88) which rests on the base plate (86), the means for indexing the bulkhead (88) including a indexing plate (102), a plurality of plug holes (105) disposed circumferentially about the indexing plate (102), and a plurality of plugs (124) which cooperate with the plug holes (105), and a center plate member (90) on which the base plate (86) rests, the support assembly (82) adapts for attaching to a means for rotating (84) the support assembly (82), which includes the steps of

(1) centering the center plate member (90) on the means for rotating (84),
(2) centering the base plate (86) with the means for indexing (88) attached on the center plate member (90),
(3) centering the hooded bulkhead portion of the combustion chamber assembly (32a) on the support assembly (82);

(b) separating the hooded bulkhead portion of the combustion chamber assembly (32a) into at least two separate elements one of which is the bulkhead (58) which includes the steps of

(1) marking reference lines (73) on the bulkhead (58), the inner ring (56) and the outer ring (57) of the bulkhead assembly (54),
(2) removing a separation region between cut surfaces on the bulkhead (58) at an outer separation area between about 0.1524 mm [six (6) thousandths of an inch] in width to about 0.2032 mm [eight (8) thousandths of an inch] in width,

(i) positioning a laser beam (80) for cutting along the outer separation area on the bulkhead (58) of the hooded bulkhead portion of the combustion chamber assembly (32a),
(ii) operating the laser beam (80) at a speed that is dependent on the material thickness of the bulkhead (58) and a power setting that will penetrate through the bulkhead material and avoid thermal distortions of adjacent surfaces or destructive exiting damage, and
(iii) cutting three hundred and sixty (360) degrees along the outer separation area,

(3) removing a separation region between cut surfaces on the bulkhead (58) at an inner separation area between about 0.1524 mm [six (6) thousandths of an inch] in width and about 0.2032 mm [eight (8) thousandths of an inch] in width,

(i) positioning the laser beam (80) for cutting along the inner separation area on the bulkhead (58) of the hooded bulkhead portion of the combustion chamber assembly (32a),
(ii) operating the laser beam (80) at a speed that is dependent on the material thickness of the bulkhead (58) and a power setting that will penetrate through the bulkhead material and avoid thermal distortions of adjacent surfaces or destructive exiting damage, and
(iii) cutting three hundred and sixty (360) degrees along the inner separation area;

(c) fixing the bulkhead (58) and a hooded portion of the combustion chamber assembly (32a) wherein repairs to the bulkhead (58) and the hooded portion of the combustion chamber assembly (32a) proceed independently, including the steps of

(1) detaching the bulkhead (58) from the hooded bulkhead portion of the combustion chamber assembly (32a),
(2) removing the hooded portion of the combustion chamber assembly (32a) from the repair apparatus (78), and
(3) repairing the bulkhead (58) and the hooded portion of the combustion chamber assembly (32a);

(d) reattaching the bulkhead (58) to the hooded portion of the combustion chamber assembly (32a), which includes the steps of

(1) supporting the hooded portion of the combustion chamber assembly (32a) on the repair apparatus (78) by engaging the locating pins (98),
(2) positioning the bulkhead (58) flush with the inner portion of bulkhead surface on the hooded portion of the combustion chamber assembly (32a) using the reference lines

(73) and plugs (124),
(3) disposing a bung plate (122) into the center of the hooded portion of the combustion chamber assembly (32a) adjacent to the inner ring (56) which includes the step of forcing the bung plate (122) into the hooded portion of the combustion chamber assembly (32a),
(4) inserting copper chill plates in the openings (62) for the fuel nozzles (34),
(5) first, welding along the inner circumference of the bulkhead (58),
(6) then, welding along the outer circumference of the bulkhead (58),
(7) restoring the predetermined relationship between the bulkhead (58) and the lug mountings (48).

15. A method for repairing a hooded bulkhead portion of a combustion chamber assembly of claim 1, comprising:

(a) supporting the hooded bulkhead portion of the combustion chamber assembly (32a) on a repair apparatus (78) of the type having a support assembly (82) having a base plate (86) which adapts for receiving a center plate member (90), locating pins (98) which extend radially, a means for indexing the bulkhead (88) which rests on the base plate (86), the means for indexing the bulkhead (88) including a indexing plate (102), a plurality of plug holes (106) disposed circumferentially about the indexing plate (102), and a plurality of plugs (124) which cooperate with the plug holes (106), and a center plate member (90) on which the base plate (86) rests, the support assembly (82) adapts for attaching to a means for rotating (84) the support assembly (82) and having a center hole (114) which adapts for receiving a locating cylinder (105), which includes the steps of

(1) centering the center plate member (90) on the means for rotating (84), which includes the steps of

(i) placing the center plate member (90) on the means for rotating (84), and
(ii) extending the locating cylinder (105) through the center plate member (90) and the hole in the means for rotating (84),

(2) centering the base plate (86) with the means for indexing (88) attached on the center plate member (90), which includes the steps of

(i) placing the base plate (86) with the means for indexing (88) attached on the center plate member (90), and
(ii) extending the locating cylinder (105) through the means for indexing (88) and the center plate member (90),

(3) centering the hooded bulkhead portion of the combustion chamber assembly (32a) on the support assembly (82), which includes the steps of

(i) engaging the plurality of lug mountings (48) with the plurality of locating pins (98), and
(ii) adjusting the location of the hooded bulkhead portion of the combustion chamber assembly (32a) on the support assembly (82) utilizing the locating pins (98) and a dial indicator (118) until concentricity of the hooded bulkhead portion of the combustion chamber assembly (32a) is achieved;

(b) separating the hooded bulkhead portion of the combustion chamber assembly (32a) into at least two separate elements one of which is the bulkhead (58) which includes the steps of

(1) marking reference lines (73) on the bulkhead (58), the inner ring (56) and the outer ring (57) of the bulkhead assembly (54),
(2) removing a separation region between cut surfaces on the bulkhead (58) at an outer separation area between about 0.1524 mm [six (6) thousandths of an inch] in width to about 0.2032 mm [eight (8) thousandths of an inch] in width,

(i) positioning a laser (80) for cutting along the outer separation area on the bulkhead (58) of the hooded bulkhead portion of the combustion chamber assembly (32a),
(ii) operating the laser (80) at a speed that is dependent on the material thickness of the bulkhead (58) and a power setting that will penetrate through the bulkhead material and avoid thermal distortions of adjacent surfaces or destructive exiting damage, and
(iii) cutting three hundred and sixty (360) degrees along the outer separation area,

(3) removing a separation region between cut surfaces on the bulkhead (58) at an in-

nar separation area between about 0.1524 mm [six (6) thousandths of an inch] in width and about 0.2032 mm [eight (8) thousandths of an inch] in width,

(i) positioning the laser (80) for cutting along the inner separation area on the bulkhead (58) of the hooded bulkhead portion of the combustion chamber assembly (32a),
(ii) operating the laser at a speed that is dependent on the material thickness of the bulkhead (58) and a power setting that will penetrate through the bulkhead material and avoid thermal distortions of adjacent surfaces or destructive exiting damage, and
(iii) cutting three hundred and sixty (360) degrees along the inner separation area;

(c) fixing the bulkhead (58) and a hooded portion of the combustion chamber assembly (32a) wherein repairs to the bulkhead (58) and the hooded portion of the combustion chamber assembly (32a) proceed independently, including the steps of

(1) detaching the bulkhead (58) from the hooded bulkhead portion of the combustion chamber assembly (32a),
(2) removing the hooded portion of the combustion chamber assembly (32a) from the repair apparatus (78), and
(3) repairing the bulkhead (58) and the hooded portion of the combustion chamber assembly (32a);

(d) reattaching the bulkhead (58) to the hooded portion of the combustion chamber assembly (32a), which includes the steps of

(1) supporting the hooded portion of the combustion chamber assembly (32a) on the repair apparatus (78) by engaging the locating pins (98),
(2) positioning the bulkhead (58) flush with the inner portion of bulkhead surface on the hooded portion of the combustion chamber assembly (32a) using the reference lines (73) and plugs (124),
(3) disposing a bung plate (122) into the center of the hooded portion of the combustion chamber assembly (32a) adjacent to the inner ring (56) which includes the step of forcing the bung plate (122) into the hooded portion of the combustion chamber assembly (32a),

(4) inserting copper chill plates in the openings (62) for the fuel nozzles (34),
(5) first, tack welding along the inner circumference of the bulkhead (58), which includes the step of

(i) tack welding at locations about 6.35 mm [one-quarter (0.25) of an inch] to about 12.7 mm [one-half (0.50) of an inch] apart around the inner circumference,
(6) then, tack welding along the outer circumference of the bulkhead (58), which includes the step of

(i) tack welding at locations about 6.35 mm [one-quarter (0.25) of an inch] to about 12.7 mm [one-half (0.50) of an inch] apart around the outer circumference,
(7) then, welding along the inner circumference of the bulkhead (58), which includes the steps of

(i) welding about 101.6 mm [four (4) inch] to 152.4 mm [six (6) inch] strips around the inner circumference at staggered locations, and

(ii) then, welding the remainder of the inner circumference,

(8) next, welding along the outer circumference of the bulkhead (58), which includes the steps of

(i) welding about 101.6 mm [four (4) inch] to 152.4 mm [six (6) inch] strips around the outer circumference at staggered locations, and
(ii) welding the remainder of the outer circumference,

(9) restoring the predetermined relationship between the bulkhead (58) and the lug mountings (48), which includes the steps of

(i) removing the hooded bulkhead portion of the combustion chamber assembly (32a) from the repair apparatus (78),
(ii) placing the hooded bulkhead portion of the combustion chamber assembly (32a) on a hydraulic cylinder and ram,
(iii) placing a contoured plate inside the hooded bulkhead portion of the combustion chamber assembly (32a), and
(iv) pulling the plate downward until the predetermined relationship between the bulkhead (58) and the lug mount-

ings (48) is restored.

16. The method of repairing a hooded bulkhead portion of a combustion chamber assembly of claim 1, wherein the combustion chamber assembly (32a) further includes an inner wall (42) spaced relatively in front of the outer wall (44) and extending substantially parallel to the outer wall (44), wherein the method of repairing includes the step of separating the inner wall (42) from the combustion chamber assembly.

17. A combustion chamber assembly repaired by the method of any one of claims 1 to 16.

Patentansprüche

1. Verfahren zum Reparieren eines mit Haube versehenen Querwandteils einer Brennkammerbaugruppe des Typs, der ein stromaufwärtiges Ende (38) hat, ein stromabwärtiges Ende (40), eine Symmetrieachse (A), eine Querwandbaugruppe (54), die einen inneren Ring (56), einen äußeren Ring (57) in radialem Abstand von dem inneren Ring (56) sowie eine ringförmige Querwand (58) aufweist, welche sich von dem inneren Ring (56) zu dem äußeren Ring (57) erstreckt, wobei die Querwand (58) eine Anzahl von Öffnungen (62) zum Orientieren von Brennstoffdüsen (34) hat, welche umfangsmäßig um die Querwand (58) angeordnet sind, wobei die Brennkammerbaugruppe (32a) weiter eine äußere Wand (44) hat, die sich stromabwärts von dem äußeren Ring (57) aus erstreckt, und eine Brennkammerhaube (46), die sich stromaufwärts von dem äußeren Ring (57) aus erstreckt, dann radial einwärts, dann stromabwärts zu dem inneren Ring (56), wobei die Brennkammerhaube (46) integrierte Befestigungsnasen (48) hat, die sich von ihr aus stromaufwärts erstrecken, um die Brennkammerbaugruppe (32a) in dem installierten Zustand zu tragen, durch:

   (a) Abtrennen der ringförmigen Querwand (58) durch Abtragen eines sich umfangsmäßig erstreckenden Teils von Material an der Querwand (58) in einem Gebiet zwischen den Öffnungen (62) für die Brennstoffdüse (34) und dem inneren Ring (56) und durch Abtragen eines sich umfangsmäßig erstreckenden Teils von Material an der Querwand (58) in einem Gebiet zwischen den Öffnungen (62) für die Brennstoffdüse (34) und dem äußeren Ring (57); und
   (b) Fixieren der Querwand (58) als ein Teil und eines mit Haube versehenen Teils der Brennkammerbaugruppe (32a) als ein separates Teil;
   (c) Wiederbefestigen der Querwand (58) an dem mit Haube versehenen Teil der Brennkammerbaugruppe (32a),

   wobei das Entfernen der Querwand (58) aus dem Bereich zwischen dem inneren Ring (56) und dem äußeren Ring (57) die Beziehung der Befestigungsnasen (48) bewahrt, die diese zu dem inneren Ring (56) und zu dem äußeren Ring (57) der Querwandbaugruppe (54) haben,
   wobei dadurch, daß die Brennkammerhaube (46) ungestört gelassen wird, der Brennkammerhaube (46) gestattet wird, den inneren Ring (56) und den äußeren Ring (57) zu verstärken und das Aufrechterhalten der ursprünglichen Orientierung in bezug auf die Befestigungsnasen (48) während der Reparaturarbeit zu unterstützen.

2. Verfahren zum Reparieren eines mit Haube versehenen Querwandteils der Brennkammerbaugruppe nach Anspruch 1, wobei der Schritt des Abtrennens der Querwand (58) weiter den Schritt beinhaltet Zurückziehen der Querwand (58), ohne die Position des inneren Ringes (56) in bezug auf die Befestigungsnasen (48) zu stören und ohne die Position des äußeren Ringes (57) in bezug auf die Befestigungsnasen (48) zu stören.

3. Verfahren zum Reparieren eines mit Haube versehenen Querwandteils der Brennkammerbaugruppe nach Anspruch 1, wobei bei dem Verfahren eine Schneidvorrichtung (80) und eine Reparaturvorrichtung (78) zum Tragen und Positionieren der Brennkammerbaugruppe (32a) in bezug auf die Schneidvorrichtung benutzt werden und wobei der Schritt des Abtrennens der Querwand (58) weiter die Schritte beinhaltet:

   (a) Positionieren der Brennkammerbaugruppe (32a) auf der Reparaturvorrichtung (78) und
   (b) Hervorrufen einer Relativdrehung zwischen der Schneidvorrichtung (80) und dem mit Haube versehenen Querwandteil der Brennkammerbaugruppe (32a).

4. Verfahren zum Reparieren eines mit Haube versehenen Querwandteils der Brennkammerbaugruppe nach Anspruch 3, wobei der Schritt des Hervorrufens einer Relativdrehung zwischen der Schneidvorrichtung (80) und dem mit Haube versehenen Querwandteil der Brennkammerbaugruppe (32a) um eine Drehachse (A) ausgeführt wird und weiter den Schritt beinhaltet Aufrechterhalten der Konzentrizität der Querwand (58) in bezug auf eine Drehachse, die mit der Symmetrieachse (A) des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a) zusammenfällt.

5. Verfahren zum Reparieren eines mit Haube verse-

henen Querwandteils der Brennkammerbaugruppe nach Anspruch 1, wobei der Schritt des Abtrennens der ringförmigen Querwand (58) durch Abtragen eines sich umfangsmäßig erstreckenden Teils von Material an der Querwand (58) in einem Gebiet zwischen den Öffnungen (62) für die Brennstoffdüsen (34) und dem inneren Ring (56) und durch Abtragen eines sich umfangsmäßig erstreckenden Teils von Material an der Querwand (58) in einem Gebiet zwischen den Öffnungen (62) für die Brennstoffdüsen (34) und dem äußeren Ring (57) weiter den Schritt beinhaltet Abtragen von weniger als etwa 1,016 mm (vierzig (40) Tausendstel Zoll) Breite an Material in den Trenngebieten.

6. Verfahren zum Reparieren eines mit Haube versehenen Querwandteils der Brennkammerbaugruppe nach Anspruch 5, wobei der Schritt des Abtragens von weniger als etwa 1,016 mm (vierzig (40) Tausendstel Zoll) an Breite von Material in den Trenngebieten weiter den Schritt beinhaltet Positionieren des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a), um den mit Haube versehenen Querwandteil der Brennkammerbaugruppe (32a) durch einen Laserstrahl (90) hindurchzuführen.

7. Verfahren zum Reparieren eines mit Haube versehenen Querwandteils der Brennkammerbaugruppe nach Anspruch 1, wobei der Schritt des Abtrennens der ringförmigen Querwand (58) durch Abtragen eines sich umfangsmäßig erstreckenden Teils von Material an der Querwand (58) in einem Gebiet zwischen den Öffnungen (62) für die Brennstoffdüsen (34) und dem inneren Ring (56) und durch Abtragen eines sich umfangsmäßig erstreckenden Teils von Material an der Querwand (58) in einem Gebiet zwischen den Öffnungen (62) für die Brennstoffdüsen (34) und dem äußeren Ring (57) weiter den Schritt beinhaltet Positionieren des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a) in bezug auf einen Laserstrahl (90) zum Hindurchführen des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a) durch den Laserstrahl.

8. Verfahren zum Reparieren eines mit Haube versehenen Querwandteils der Brennkammerbaugruppe nach Anspruch 1, wobei der Schritt des Abtrennens der Querwand weiter die Schritte beinhaltet Abtragen eines sich umfangsmäßig erstreckenden Teils von Material an der Querwand (58) in einem Gebiet in unmittelbarer Nähe des inneren Ringes (56) und Abtragen eines sich umfangsmäßig erstreckenden Teils von Material an der Querwand (58) in einem Gebiet in unmittelbarer Nähe des äußeren Ringes (57).

9. Verfahren zum Reparieren eines mit Haube versehenen Querwandteils der Brennkammerbaugruppe nach Anspruch 8, wobei die Schritte des Abtragens von Material in zwei sich umfangsmäßig erstreckenden Gebieten weiter die Schritte beinhalten Abtragen eines sich umfangsmäßig erstreckenden Teils von Material an der Querwand (58) in einem Gebiet, das mit der früheren Schweißverbindung an dem inneren Ring (56) zusammenfällt, und Abtragen eines sich umfangsmäßig erstreckenden Teils von Material an der Querwand (58) in einem Gebiet, das mit der früheren Schweißverbindung an dem äußeren Ring (57) zusammenfällt.

10. Verfahren zum Reparieren eines mit Haube versehenen Querwandteils der Brennkammerbaugruppe nach Anspruch 1, wobei der Schritt des Fixierens der Querwand (58) als ein Teil und des mit Haube versehenen Teils der Brennkammerbaugruppe (32a) als ein separates Teil weiter den Schritt beinhaltet Wiederherstellen der Querwand (58) und des mit Haube versehenen Teils der Brennkammerbaugruppe (32a) während Zeitspannen, die teilweise zusammenfallen.

11. Verfahren zum Reparieren eines mit Haube versehenen Querwandteils der Brennkammerbaugruppe nach Anspruch 1, wobei der Schritt des Wiederbefestigens der Querwand (58) an dem mit Haube versehenen Teil der Brennkammerbaugruppe (32a) weiter den Schritt beinhaltet Positionieren der Querwand (58) in bezug auf den mit Haube versehenen Teil der Brennkammerbaugruppe (32a), der weiter die Schritte beinhaltet axiales Festlegen der Querwand (58) in bezug auf den inneren Ring (56) und den äußeren Ring (57) und umfangsmäßiges Festlegen der Querwand (58) in bezug auf die Befestigungsnasen (48).

12. Verfahren zum Reparieren eines mit Haube versehenen Querwandteils der Brennkammerbaugruppe nach Anspruch 11, wobei der Schritt des Positionierens der Querwand (58) weiter den Schritt beinhaltet Orientieren der Querwand (58) derart, daß der Winkel (α) der Querwand (58) in bezug auf eine Bezugsebene, die durch die Befestigungsnasen (48) definiert ist, innerhalb von vorbestimmten Grenzen ist, welche für eine neu hergestellte Brennkammerbaugruppe festgelegt sind.

13. Verfahren zum Reparieren eines mit Haube versehenen Querwandteils der Brennkammerbaugruppe nach Anspruch 1, wobei der Schritt des Wiederbefestigens der Querwand (58) an dem mit Haube versehenen Teil der Brennkammerbaugruppe (32a) weiter den Schritt beinhaltet Anordnen einer Spundplatte (122) innerhalb des mit Haube versehenen Teils der Brennkammerbaugruppe (32a), um

die Verwindung zu minimieren, die die Querwand (58) während des Wiederzusammenbaus erfährt, und um die Konzentrizität des inneren Ringes (56) der Querwandbaugruppe (54) aufrechtzuerhalten.

14. Verfahren zum Reparieren eines mit Haube versehenen Querwandteils einer Brennkammerbaugruppe nach Anspruch 1, durch:

(a) Abstützen des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a) auf einer Reparaturvorrichtung (78) des Typs, der eine Haltebaugruppe (82) hat, die eine Grundplatte (86) aufweist, welche sie in die Lage versetzt, eine Mittelplatte (90) aufzunehmen, Paßstifte (98), die sich radial erstrecken, eine Einrichtung zum Weiterschalten der Querwand (88), die auf der Grundplatte (86) ruht, wobei die Einrichtung zum Weiterschalten der Querwand (88) eine Weiterschaltplatte (102) aufweist, mehrere Stopfenlöcher (106), die umfangsmäßig um die Weiterschaltplatte (102) angeordnet sind, und mehrere Stopfen (124), die mit den Stopfenlöchern (106) zusammenwirken, und eine Mittelplatte (90), auf der die Grundplatte (86) ruht, wobei die Haltebaugruppe (82) das Befestigen an einer Einrichtung zum Drehen (84) der Haltebaugruppe (82) ermöglicht, was die Schritte beinhaltet

(1) Zentrieren der Mittelplatte (90) auf der Dreheinrichtung (84),
(2) Zentrieren der Grundplatte (86) mit der Weiterschalteinrichtung (88), die auf der Mittelplatte (90) befestigt ist,
(3) Zentrieren des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a) auf der Haltebaugruppe (82);

(b) Auftrennen des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a) in wenigstens zwei separate Elemente, von denen eines die Querwand (58) ist, was die Schritte beinhaltet

(1) Markieren von Bezugslinien (73) auf der Querwand (58), dem inneren Ring (56) und dem äußeren Ring (57) der Querwandbaugruppe (54),
(2) Abtragen eines Trenngebietes zwischen Schnittflächen an der Querwand (58) in einem äußeren Trennbereich zwischen etwa 0,1524 mm (sechs (6) Tausendstel Zoll) Breite bis etwa 0,2032 mm (acht (8) Tausendstel Zoll) Breite,

(i) Positionieren eines Laserstrahls (80) zum Schneiden längs des äußeren Trennbereiches an der Querwand (58) des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a),
(ii) Betreiben des Laserstrahls (80) mit einer Geschwindigkeit, die von der Materialdicke der Querwand (58) abhängig ist, und mit einer Leistungseinstellung, bei welcher er das Querwandmaterial durchdringen wird und thermische Verwindung von benachbarten Oberflächen oder zerstörerischer Austrittsschaden vermieden wird, und
(iii) Schneiden auf dreihundertsechzig (360) Grad längs des äußeren Trennbereiches,

(3) Entfernen eines Trenngebietes zwischen Schnittflächen an der Querwand (58) in einem inneren Trennbereich zwischen etwa 0,1524 mm (sechs (6) Tausendstel Zoll) Breite und etwa 0,2032 mm (acht (8) Tausendstel Zoll) Breite,

(i) Positionieren des Laserstrahls (80) zum Schneiden längs des inneren Trennbereiches an der Querwand (58) des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a),
(ii) Betreiben des Laserstrahls (80) mit einer Geschwindigkeit, die von der Materialdicke der Querwand (58) abhängig ist, und mit einer Leistungseinstellung, bei welcher er das Querwandmaterial durchdringen wird und thermische Verwindung von benachbarten Oberflächen oder zerstörerischer Austrittsschaden vermieden wird, und
(iii) Schneiden auf dreihundertsechzig (360) Grad längs des inneren Trennbereiches;

(c) Fixieren der Querwand (58) und eines mit Haube versehenen Teils der Brennkammerbaugruppe (32a), wobei Reparaturen an der Querwand (58) und dem mit Haube versehenen Teil der Brennkammerbaugruppe (32a) unabhängig vonstatten gehen, beinhaltend die Schritte

(1) Lösen der Querwand (58) von dem mit Haube versehenen Querwandteil der Brennkammerbaugruppe (32a),
(2) Entfernen des mit Haube versehenen Teils der Brennkammerbaugruppe (32a)

aus der Reparaturvorrichtung (78), und
(3) Reparieren der Querwand (58) und des mit Haube versehenen Teils der Brennkammerbaugruppe (32a);

(d) Wiederbefestigen der Querwand (58) an dem mit Haube versehenen Teil der Brennkammerbaugruppe (32a), was die Schritte beinhaltet

(1) Abstützen des mit Haube versehenen Teils der Brennkammerbaugruppe (32a) auf der Reparaturvorrichtung (78) durch Erfassen der Paßstifte (98),
(2) Positionieren der Querwand (58) bündig mit dem inneren Teil der Querwandoberfläche an dem mit Haube versehenen Teil der Brennkammerbaugruppe (32a) unter Verwendung der Bezugslinien (73) und der Stopfen (124),
(3) Anordnen einer Stopfenplatte (122) in dem Zentrum des mit Haube versehenen Teils der Brennkammerbaugruppe (32a) an dem inneren Ring (56), was den Schritt beinhaltet Drücken der Stopfenplatte (122) in den mit Haube versehenen Teil der Brennkammerbaugruppe (32a),
(4) Einführen von Abschreckplatten aus Kupfer in die Öffnungen (62) für die Brennstoffdüsen (34),
(5) erstens, Schweißen längs des inneren Umfangs der Querwand (58),
(6) anschließend Schweißen längs des äußeren Umfangs der Querwand (58),
(7) Wiederherstellen der vorbestimmten Beziehung zwischen der Querwand (58) und den Befestigungsnasen (48).

15. Verfahren zum Reparieren eines mit Haube versehenen Querwandteils einer Brennkammerbaugruppe nach Anspruch 1, durch:

(a) Abstützen des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a) auf einer Reparaturvorrichtung (78) des Typs, der eine Haltebaugruppe (82) aufweist, die eine Grundplatte (86) hat, welche das Aufnehmen einer Mittelplatte (90) gestattet, Paßstifte (98), die sich radial erstrecken, eine Einrichtung zum Weiterschalten der Querwand (88), die auf der Grundplatte (86) ruht, wobei die Einrichtung zum Weiterschalten der Querwand (88) eine Weiterschaltplatte (102) aufweist, mehrere Stopfenlöcher (106), die umfangsmäßig um die Weiterschaltplatte (102) angeordnet sind, und mehrere Stopfen (124), die mit den Stopfenlöchern (106) zusammenwirken, sowie eine Mittelplatte (90), auf der die Grundplatte (86) ruht, wobei die Haltebaugruppe (82) das Befestigen an einer Einrichtung (84) zum Drehen der Haltebaugruppe (82) ermöglicht und ein mittiges Loch (114) hat, welches das Empfangen eines Paßzylinders (105) ermöglicht, was die Schritte beinhaltet

(1) Zentrieren der Mittelplatte (90) auf der Dreheinrichtung (84), was die Schritte umfaßt

(i) Plazieren der Mittelplatte (90) auf der Dreheinrichtung (84), und
(ii) Einführen des Paßzylinders (105) in die Mittelplatte (90) und in das Loch in der Dreheinrichtung (84),

(2) Zentrieren der Grundplatte (86) mit der Weiterschalteinrichtung (88), die auf der Mittelplatte (90) befestigt ist, was die Schritte umfaßt

(i) Plazieren der Grundplatte (86) mit der auf der Mittelplatte (90) befestigten Weiterschalteinrichtung (88), und
(ii) Einführen des Paßzylinders (105) in die Weiterschalteinrichtung (88) und in die Mittelplatte (90),

(3) Zentrieren des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a) auf der Haltebaugruppe (82), was die Schritte beinhaltet

(i) Erfassen der mehreren Befestigungsnasen (48) mit den mehreren Paßstiften (98), und
(ii) Justieren der Lage des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a) auf der Haltebaugruppe (82) unter Verwendung der Paßstifte (98) und einer Meßuhr (118), bis Konzentrizität des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a) erzielt ist;

(b) Auftrennen des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a) in wenigstens zwei separate Elemente, von denen eines die Querwand (58) ist, was die Schritte beinhaltet

(1) Markieren von Bezugslinien (73) auf der Querwand (58), dem inneren Ring (56) und dem äußeren Ring (57) der Querwandbaugruppe (54),
(2) Entfernen eines Trenngebietes zwischen Schnittflächen an der Querwand

(58) in einem äußeren Trennbereich zwischen etwa 0,1524 mm (sechs (6) Tausendstel Zoll) Breite bis etwa 0,2032 mm (acht (8) Tausendstel Zoll) Breite,

(i) Positionieren eines Lasers (80) zum Schneiden längs des äußeren Trennbereiches an der Querwand (58) des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a),
(ii) Betreiben des Lasers (80) mit einer Geschwindigkeit, die von der Materialdicke der Querwand (58) abhängig ist, und mit einer Leistungseinstellung, bei der er das Querwandmaterial durchdringen wird und thermische Verwindung von benachbarten Oberflächen oder zerstörerischer Austrittsschaden vermieden wird, und
(iii) Schneiden auf dreihundertsechzig (360) Grad längs des äußeren Trennbereiches,

(3) Entfernen eines Trenngebietes zwischen Schnittflächen an den Querwand (58) in einem inneren Trenngebiet zwischen etwa 0,1524 mm (sechs (6) Tausendstel Zoll) Breite und etwa 0,2032 mm (acht (8) Tausendstel Zoll) Breite,

(i) Positionieren des Lasers (80) zum Schneiden längs des inneren Trennbereiches an der Trennwand (58) des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a),
(ii) Betreiben des Lasers mit einer Geschwindigkeit, die von der Materialdikke der Querwand (58) abhängig ist, und mit einer Leistungseinstellung, bei der er das Querwandmaterial durchdringen wird und thermische Verwindung von benachbarten Oberflächen oder zerstörerischer Austrittsschaden vermieden wird, und
(iii) Schneiden auf dreihundertsechzig (360) Grad längs des inneren Trennbereiches;

c) Fixieren der Querwand (58) und eines mit Haube versehenen Teils der Brennkammerbaugruppe (32a), wobei Reparaturen an der Querwand (58) und an dem mit Haube versehenen Teil der Brennkammerbaugruppe (32a) unabhängig vonstatten gehen, beinhaltend die Schritte

(1) Lösen der Querwand (58) von dem mit Haube versehenen Querwandteil der Brennkammerbaugruppe (32a),
(2) Entfernen des mit Haube versehenen Teils der Brennkammerbaugruppe (32a) von der Reparaturvorrichtung (78), und
(3) Reparieren der Querwand (58) und des mit Haube versehenen Teils der Brennkammerbaugruppe (32a);

(d) Wiederbefestigen der Querwand (58) an dem mit Haube versehenen Teil der Brennkammerbaugruppe (32a), was die Schritte beinhaltet

(1) Abstützen des mit Haube versehenen Teils der Brennkammerbaugruppe (32a) auf der Reparaturvorrichtung (78) durch Erfassen der Paßstifte (98),
(2) Positionieren der Querwand (58) bündig mit dem inneren Teil der Querwandoberfläche an dem mit Haube versehenen Teil der Brennkammerbaugruppe (32a) unter Verwendung der Bezugslinien (73) und der Stopfen (124),
(3) Anordnen einer Spundplatte (122) in dem Zentrum des mit Haube versehenen Teils der Brennkammerbaugruppe (32a) benachbart zu dem inneren Ring (56), was den Schritt beinhaltet, die Spundplatte (122) in den mit Haube versehenen Teil der Brennkammerbaugruppe (32a) zu drükken,
(4) Einführen von Abschreckplatten aus Kupfer in die Öffnungen (62) für die Brennstoffdüsen (34),
(5) erstens, Heftschweißen längs des inneren Umfangs der Querwand (58), was den Schritt beinhaltet

(i) Heftschweißen an Stellen, die etwa 6,35 mm (ein Viertel (0.25) Zoll) bis etwa 12,7 mm (ein halbes (0.50) Zoll beabstandeten Stellen an dem inneren Umfang,

(6) dann, Heftschweißen längs des äußeren Umfangs der Querwand (58), was den Schritt beinhaltet

(i) Heftschweißen an etwa 6,35 mm (ein Viertel (0.25) Zoll) bis etwa 12,7 mm (ein halbes (0.50) Zoll) beabstandeten Stellen an dem äußeren Umfang,

(7) dann, Schweißen längs des inneren Umfangs der Querwand (58), was die Schritte beinhaltet

(i) Schweißen von etwa 101,6 mm (vier (4) Zoll) bis 152,4 mm (sechs (6) Zoll) Streifen an dem inneren Umfang an versetzten Stellen, und
(ii) dann, Schweißen des übrigen Teils des inneren Umfangs.

(8) danach, Schweißen längs des äußeren Umfangs der Querwand (58), was die Schritte beinhaltet

(i) Schweißen von etwa 101,6 mm (vier (4) Zoll) bis 152,4 mm (sechs (6) Zoll) Streifen an dem äußeren Umfang an versetzten Stellen, und
(ii) Schweißen des übrigen Teils des äußeren Umfangs,

(9) Wiederherstellen der vorbestimmten Beziehung zwischen der Querwand (58) und den Befestigungsnasen (48), was die Schritte beinhaltet

(i) Entfernen des mit Haube versehenen Querwandteils der Brennkammer (32a) von der Reparaturvorrichtung (78),
(ii) Plazieren des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a) auf einer Hydraulik-Kolben-Zylinder-Vorrichtung,
(iii) Plazieren einer konturierten Platte innerhalb des mit Haube versehenen Querwandteils der Brennkammerbaugruppe (32a), und
(iv) Ziehen der Platte abwärts, bis die vorbestimmte Beziehung zwischen der Querwand (58) und den Befestigungsnasen (48) wiederhergestellt ist.

16. Verfahren zum Reparieren eines mit Haube versehenen Querwandteils einer Brennkammerbaugruppe nach Anspruch 1, wobei die Brennkammerbaugruppe (32a) weiter eine innere Wand (42) aufweist, die relativ beabstandet vor der äußeren Wand (44) angeordnet ist und sich im wesentlichen parallel zu der äußeren Wand (44) erstreckt, wobei das Verfahren zum Reparieren den Schritt beinhaltet, die innere Wand (42) von der Brennkammerbaugruppe abzutrennen.

17. Brennkammerbaugruppe, die durch das Verfahren nach einem der Ansprüche 1 bis 16 repariert worden ist.

Revendications

1. Procédé de remise en état d'une partie capotée à cloison de séparation d'un ensemble de chambre de combustion, du type ayant une extrémité amont (38), une extrémité aval (40), un axe de symétrie A, un ensemble de cloison de séparation (54) qui comporte un anneau interne (56), un anneau externe (57) espacé radialement de l'anneau interne (56) et une cloison de séparation annulaire (58) s'étendant à partir de l'anneau interne (56) jusqu'à l'anneau externe (57), la cloison de séparation (58) présentant un certain nombre d'ouvertures (62) pour orienter des injecteurs de carburant (34) disposés circonférentiellement autour de la cloison de séparation (58), et un ensemble de chambre de combustion (32) comportant en outre une paroi externe (44) s'étendant vers l'aval à partir de l'anneau externe (57) et un capot de chambre de combustion (46) s'étendant vers l'amont à partir de l'anneau externe (57), puis radialement vers l'intérieur puis vers l'aval en direction de l'anneau interne (56), le capot (46) de la chambre de combustion comportant des pattes de montage intégrales (48) s'étendant à partir de ce capot vers l'amont, afin de supporter l'ensemble de chambre de combustion (32) à l'état installé, caractérisé en ce qu'il comprend les étapes consistant :

a) à séparer la cloison de séparation annulaire (58) en enlevant, sur la cloison de séparation (58), une portion de matière s'étendant circonférentiellement, dans une zone comprise entre les ouvertures (62) pour les injecteurs de carburant (34) et l'anneau interne (56), et en enlevant, sur la cloison de séparation (58), une portion de matière s'étendant circonférentiellement, dans une zone comprise entre les ouvertures (62) pour les injecteurs de carburant (34) et l'anneau externe (57),
b) à fixer la cloison de séparation (58) en tant que première pièce et une partie capotée de l'ensemble de chambre de combustion (32a), en tant que seconde pièce séparée, et
c) à réattacher la cloison de séparation (58) à la partie capotée de l'ensemble de chambre de combustion (32a),

l'enlèvement de la cloison de séparation (58) d'entre l'anneau interne (56) et l'anneau externe (57) préservant la relation que les pattes de montage (48) ont avec l'anneau interne (56) et l'anneau externe (57) de l'ensemble de cloison de séparation (54), et le fait de laisser le capot (45) de la chambre de combustion non dérangé permettant à ce capot (46) de la chambre de combustion de renforcer l'anneau interne (56) et l'anneau externe (57) et contribuant au maintien de l'orientation originale par rapport aux pattes de montage (48) pendant l'opération de remise en état.

2. Procédé de remise en état d'une partie capotée à cloison de séparation d'un ensemble de chambre de combustion suivant la revendication 1 caractérisé en ce que l'étape de séparation de la cloison de séparation (58) comporte en outre l'étape d'extraction de la cloison de séparation (58) sans perturber

la position de l'anneau interne (56) par rapport aux pattes de montage (48) sans perturber la position de l'anneau externe (57) par rapport aux pattes de montage (48).

3. Procédé de remise en état d'une partie capotée à cloison de séparation d'un ensemble de chambre de combustion suivant la revendication 1 caractérisé en ce qu'il utilise un dispositif de coupe (80) et un appareil de remise en état (78) pour supporter et maintenir en position l'ensemble de chambre de combustion (32a) par rapport au dispositif de coupe, et l'étape de séparation de la cloison de séparation (58) comporte en outre les étapes consistant (a) à mettre en position l'ensemble de chambre de combustion (32a) sur l'appareil de remise en état (78) et (b) à provoquer une rotation relative entre le dispositif de coupe (80) et la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion.

4. Procédé de remise en état d'une partie capotée à cloison de séparation d'un ensemble de chambre de combustion suivant la revendication 3 caractérisé en ce que l'étape consistant à provoquer une rotation relative entre le dispositif de coupe (80) et la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion a lieu autour d'un axe de rotation A et elle comporte en outre l'étape consistant à maintenir la concentricité de la cloison de séparation (58) par rapport à un axe de rotation correspondant avec l'axe de symétrie A de la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion.

5. Procédé de remise en état d'une partie capotée à cloison de séparation d'un ensemble de chambre de combustion suivant la revendication 1 caractérisé en ce que l'étape de séparation de la cloison de séparation annulaire (58) en enlevant, sur la cloison de séparation (58), une portion de matière s'étendant circonférentiellement, dans une zone comprise entre les ouvertures (62) pour les injecteurs de carburant (34) et l'anneau interne (56), et en enlevant, sur la cloison de séparation (58), une portion de matière s'étendant circonférentiellement, dans une zone comprise entre les ouvertures (62) pour les injecteurs de carburant (34) et l'anneau externe (57), comporte en outre l'étape consistant à enlever une largeur de matière inférieure à environ 1,016 mm (40 millièmes de pouce) dans les zones de séparation.

6. Procédé de remise en état d'une partie capotée à cloison de séparation d'un ensemble de chambre de combustion suivant la revendication 5 caractérisé en ce que l'étape d'enlèvement d'une largeur de matière de moins de 1,016 mm (40 millièmes de pouce) dans les zones de séparation comporte en outre l'étape consistant à mettre en position la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion de manière à faire passer cette partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion à travers un faisceau laser (80).

7. Procédé de remise en état d'une partie capotée à cloison de séparation d'un ensemble de chambre de combustion suivant la revendication 1 caractérisé en ce que l'étape de séparation de la cloison de séparation annulaire (58) en enlevant, sur la cloison de séparation (58), une portion de matière s'étendant circonférentiellement, dans une zone comprise entre les ouvertures (62) pour les injecteurs de carburant (34) et l'anneau interne (56), et en enlevant, sur la cloison de séparation (58), une portion de matière s'étendant circonférentiellement, dans une zone comprise entre les ouvertures (62) pour les injecteurs de carburant (34) et l'anneau externe (57), comporte en outre l'étape consistant à mettre en position la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion par rapport à un faisceau laser (80) de manière à faire passer la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion à travers le faisceau laser.

8. Procédé de remise en état d'une partie capotée à cloison de séparation d'un ensemble de chambre de combustion suivant la revendication 1 caractérisé en ce que l'étape de séparation de la cloison de séparation (58) comporte en outre les étapes consistant à enlever, sur la cloison de séparation (58), une portion de matière s'étendant circonférentiellement, dans une zone située à proximité immédiate d'un anneau interne (56), et à enlever, sur la cloison de séparation (58), une portion de matière s'étendant circonférentiellement, dans une zone située à proximité immédiate de l'anneau externe (57).

9. Procédé de remise en état d'une partie capotée à cloison de séparation d'un ensemble de chambre de combustion suivant la revendication 8 caractérisé en ce que l'étape d'enlèvement de matière à l'endroit de deux zones s'étendant circonférentiellement comporte en outre les étapes consistant à enlever, sur la cloison de séparation (58), une portion de matière s'étendant circonférentiellement, dans une zone coïncidant avec le joint de soudure précédent adjacent à l'anneau interne (56), et à enlever, sur la cloison de séparation (58), une portion de matière s'étendant circonférentiellement, à l'endroit d'une zone coïncidant avec le joint de soudure précédent adjacent à l'anneau externe (57).

10. Procédé de remise en état d'une partie capotée à

cloison de séparation d'un ensemble de chambre de combustion suivant la revendication 1 caractérisé en ce que l'étape de fixation de la cloison de séparation (58) en tant que première pièce et de la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion en tant que pièce séparée comporte en outre l'étape de remise en état de la cloison de séparation (58) et de la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion pendant des périodes de temps qui coïncident partiellement.

11. Procédé de remise en état d'une partie capotée à cloison de séparation d'un ensemble de chambre de combustion suivant la revendication 1 caractérisé en ce que l'étape de refixation de la cloison de séparation (58) à la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion comporte en outre l'étape consistant à mettre en position la cloison de séparation (58) par rapport à la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion, étape comportant additionnellement les étapes consistant à mettre en position, axialement, la cloison de séparation (58) par rapport à l'anneau interne (56) et à l'anneau externe (57) et à mettre en position, circonférentiellement, la cloison de séparation (58) par rapport aux pattes de montage (48).

12. Procédé de remise en état d'une partie capotée à cloison de séparation d'un ensemble de chambre de combustion suivant la revendication 11 caractérisé en ce que l'étape de mise en position de la cloison de séparation (58) comporte en outre l'étape consistant à orienter la cloison de séparation (58) de telle façon que l'angle (α) de la cloison de séparation (58), par rapport à un plan de référence délini par les pattes de montage (48), soit compris dans des limites prédéterminées établies pour un ensemble de chambre de combustion nouvellement fabriqué.

13. Procédé de remise en état d'une partie capotée à cloison de séparation d'un ensemble de chambre de combustion suivant la revendication 1 caractérisé en ce que l'étape de refixation de la cloison de séparation (58) à la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion comporte en outre l'étape consistant à disposer une plaque formant "bondon" (122) à l'intérieur de la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion, afin de réduire au minimum la distorsion à laquelle la cloison de séparation (58) est soumise pendant le remontage et de maintenir la concentricité de l'anneau interne (56) de l'ensemble de cloison de séparation (54).

14. Procédé de remise en état d'une partie capotée à cloison de séparation d'un ensemble de chambre de combustion suivant la revendication 1 caractérisé en ce qu'il comprend les étapes consistant

(a) à supporter la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion sur un appareil de remise en état (78) du type comportant un ensemble de support (82) ayant une plaque de base (86) l'adaptant à la réception d'une plaque centrale (90), des chevilles de mise en position (98) qui s'étendent radialement, un moyen (88) pour indexer la cloison d séparation qui repose sur la plaque de base (86), le moyen (88) pour indexer la cloison de séparation comprenant une plaque d'indexation (102), une pluralité de trous (106) de réception de bouchon disposés circonférentiellement autour de la plaque d'indexation (102) et une pluralité de bouchons (124) qui coopèrent avec les trous de réception de bouchon (106), et une plaque centrale (90) sur laquelle repose la plaque de base (86), l'ensemble de support (82) étant adapté de manière à être fixé à un moyen (84) pour entraîner en rotation l'ensemble de support (82), cette étape comportant les étapes consistant

(1) à centrer la plaque centrale (90) sur le moyen (84) d'entraînement en rotation,
(2) à centrer la plaque de base (86) avec le moyen d'indexation (88) attaché sur la plaque centrale (90),
(3) à centrer la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion sur l'ensemble de support (82),

(b) à séparer la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion en au moins deux éléments séparés dont l'un est la cloison de séparation (58), cette étape comportant les étapes consistant

(1) à marquer des lignes de référence (73) sur la cloison de séparation (58), sur l'anneau interne (56) et sur l'anneau externe (57) de l'ensemble de cloison de séparation (54),
(2) à enlever une zone de séparation entre des surfaces de coupe sur la cloison de séparation (58), dans une zone de séparation externe ayant une largeur allant d'environ 0,1524 mm (6 millièmes de pouce) à environ 0,2032 mm (8 millièmes de pouce),

(i) à placer un faisceau laser (80) en vue d'une coupe le long de la zone de

séparation externe sur la cloison de séparation (58) de la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion,
(ii) à faire fonctionner le faisceau laser (80) à une vitesse qui dépend de l'épaisseur de la matière de la cloison de séparation (58) et d'un réglage de puissance assurant une pénétration à travers la matière de la cloison de séparation et évitant des distorsions thermiques de surfaces adjacentes ou des dommages destructifs, et
(iii) à effectuer une coupe suivant trois cent soixante (360°) degrés le long de la zone de séparation externe,

(3) à enlever une zone de séparation entre des surfaces de coupe sur la cloison de séparation (58), dans une zone de séparation interne ayant une largeur allant d'environ 0,1524 mm (6 millièmes de pouce) à environ 0,2032 mm (8 millièmes de pouce),

(i) à placer un faisceau laser (80) en vue d'une coupe le long de la zone de séparation interne sur la cloison de séparation (58) de la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion,
(ii) à faire fonctionner le faisceau laser (80) à une vitesse qui dépend de l'épaisseur de la matière de la cloison de séparation (58) et d'un réglage de puissance assurant une pénétration à travers la matière de la cloison de séparation et évitant des distorsions thermiques de surfaces adjacentes ou des dommages destructifs, et
(iii) à effectuer une coupe suivant trois cent soixante (360°) degrés le long de la zone de séparation interne,

(c) à fixer la cloison de séparation (58) et une partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion, la remise en état de la cloison de séparation (58) et de la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion ayant lieu indépendamment, cette étape comportant les étapes consistant

(1) à détacher la cloison de séparation (58) de la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion,
(2) à enlever la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion de l'appareil de remise en état (78) et
(3) à remettre en état la cloison de séparation (58) et la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion

(d) à réattacher la cloison de séparation (58) à la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion, cette étape comportant les étapes consistant

(1) à supporter la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion sur l'appareil de remise en état (78) en engageant les chevilles de mise en position (98),
(2) à placer la cloison de séparation (58) à fleur avec la portion interne de la surface de la cloison de séparation (58) se trouvant sur la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion, en utilisant les lignes de référence (173) et les bouchons (124),
(3) à disposer une plaque formant "bondon" (122) dans la partie centrale de la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion, de manière qu'elle soit adjacente à l'anneau interne (56), cette étape comportant l'étape consistant à forcer la plaque formant "bondon" (122) vers et dans la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion,
(4) à introduire des plaques de refroidissement en cuivre dans les ouvertures (62) prévues pour les injecteurs de carburant (34),
(5) à effectuer en premier lieu un soudage le long de la circonférence interne de la cloison de séparation (58),
(6) à effectuer ensuite un soudage le long de la circonférence externe de la cloison de séparation (58),
(7) à rétablir la relation prédéterminée entre la cloison de séparation (58) et les pattes de montage (48).

15. Procédé de remise en état d'une partie capotée à cloison de séparation d'un ensemble de chambre de combustion suivant la revendication 1 caractérisé en ce qu'il comprend les étapes consistant

(a) à supporter la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion sur un appareil de remise en état (78) du type comportant un ensemble de support (82) ayant une plaque de base (86) l'adap-

tant à la réception d'une plaque centrale (90), des chevilles de mise en position (98) qui s'étendent radialement, un moyen (88) pour indexer la cloison d séparation qui repose sur la plaque de base (86), le moyen (88) pour indexer la cloison de séparation comprenant une plaque d'indexation (102), une pluralité de trous (106) de réception de bouchon disposés circonférentiellement autour de la plaque d'indexation (102) et une pluralité de bouchons (124) qui coopèrent avec les trous de réception de bouchon (106), et une plaque centrale (90) sur laquelle repose la plaque de base (86), l'ensemble de support (82) étant adapté de manière à être fixé à un moyen (84) pour entraîner en rotation l'ensemble de support (82), et ayant une ouverture centrale (114) l'adaptant à la réception d'un cylindre de mise en position (105), cette étape comportant les étapes consistant

(1) à centrer la plaque centrale (90) sur le moyen (84) d'entraînement en rotation, cette étape comportant les étapes consistant

(i) à placer la plaque centrale (90) sur le moyen d'entraînement en rotation (84) et
(ii) à étendre le cylindre de mise en position (105) à travers la plaque centrale (90) et l'ouverture prévue dans le moyen d'entraînement en rotation (84),

(2) à centrer la plaque de base (86) avec le moyen d'indexation (88) attaché sur la plaque centrale (90), cette étape comportant les étapes consistant

(i) à placer la plaque de base (86) avec le moyen d'indexation (88) attaché sur la plaque centrale (90) et
(ii) à étendre le cylindre de mise en position (105) à travers le moyen d'indexation (88) et la plaque centrale (90),

(3) à centrer la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion sur l'ensemble de support (82), cette étape comportant les étapes consistant

(i) à engager la pluralité de chevilles de mise en position (98) dans la pluralité de pattes de montage (48) et
(ii) à ajuster la position de la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion sur l'ensemble de support (82) en utilisant les chevilles de mise en position (98) et un indicateur à cadran (118) jusqu'à ce que la concentricité de la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion soit obtenue,

(b) à séparer la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion en au moins deux éléments séparés dont l'un est la cloison de séparation (58), cette étape comportant les étapes consistant

(1) à marquer des lignes de référence (73) sur la cloison de séparation (58), sur l'anneau interne (56) et sur l'anneau externe (57) de l'ensemble de cloison de séparation (54),
(2) à enlever une zone de séparation entre des surfaces de coupe sur la cloison de séparation (58), dans une zone de séparation externe ayant une largeur allant d'environ 0,1524 mm (6 millièmes de pouce) à environ 0,2032 mm (8 millièmes de pouce),

(i) à placer un faisceau laser (80) en vue d'une coupe le long de la zone de séparation externe sur la cloison de séparation (58) de la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion,
(ii) à faire fonctionner le faisceau laser (80) à une vitesse qui dépend de l'épaisseur de la matière de la cloison de séparation (58) et d'un réglage de puissance assurant une pénétration à travers la matière de la cloison de séparation et évitant des distorsions thermiques de surfaces adjacentes ou des dommages destructifs, et
(iii) à effectuer une coupe suivant trois cent soixante (360°) degrés le long de la zone de séparation externe,

(3) à enlever une zone de séparation entre des surfaces de coupe sur la cloison de séparation (58), dans une zone de séparation interne ayant une largeur allant d'environ 0,1524 mm (6 millièmes de pouce) à environ 0,2032 mm (8 millièmes de pouce),

(i) à placer un faisceau laser (80) en vue d'une coupe le long de la zone de séparation interne sur la cloison de séparation (58) de la partie capotée (32a) à cloison de séparation de l'en-

semble de chambre de combustion,
(ii) à faire fonctionner le faisceau laser (80) à une vitesse qui dépend de l'épaisseur de la matière de la cloison de séparation (58) et d'un réglage de puissance assurant une pénétration à travers la matière de la cloison de séparation et évitant des distorsions thermiques de surfaces adjacentes ou des dommages destructifs, et
(iii) à effectuer une coupe suivant trois cent soixante (360°) degrés le long de la zone de séparation interne,

(c) à fixer la cloison de séparation (58) et une partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion, la remise en état de la cloison de séparation (58) et de la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion ayant lieu indépendamment, cette étape comportant les étapes consistant

(1) à détacher la cloison de séparation (58) de la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion,
(2) à enlever la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion de l'appareil de remise en état (78) et
(3) à remettre en état la cloison de séparation (58) et la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion

(d) à réattacher la cloison de séparation (58) à la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion, cette étape comportant les étapes consistant

(1) à supporter la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion sur l'appareil de remise en état (78) en engageant les chevilles de mise en position (98),
(2) à placer la cloison de séparation (58) à fleur avec la portion interne de la surface de la cloison de séparation (58) se trouvant sur la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion, en utilisant les lignes de référence (173) et les bouchons (124),
(3) à disposer une plaque formant "bondon" (122) dans la partie centrale de la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion, de manière qu'elle soit adjacente à l'anneau interne (56), cette étape comportant l'étape consistant à forcer la plaque formant "bondon" (122) vers et dans la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion,
(4) à introduire des plaques de refroidissement en cuivre dans les ouvertures (62) prévues pour les injecteurs de carburant (34),
(5) à effectuer en premier lieu un soudage par points le long de la circonférence interne de la cloison de séparation (58), cette étape comportant l'étape consistant

(i) à effectuer ur soudage par points en des emplacements situés à une distance les uns des autres allant d'environ 6,35 mm (un quart de pouce) à environ 12,7 mm (un demi pouce) autour de la circonférence interne

(6) à effectuer ensuite un soudage par points le long de la circonférence externe de la cloison de séparation (58), cette étape comportant l'étape consistant

(i) à effectuer un soudage par points en des emplacements situés à une distance les uns des autres allant d'environ 6,35 mm (un quart de pouce) à environ 12,7 mm (un demi pouce) autour de la circonférence externe

(7) à effectuer ensuite un soudage le long de la circonférence interne de la cloison de séparation (58), cette étape comportant les étapes consistant

(i) à effectuer un soudage de bandes allant d'environ 101,6 mm (4 pouces) à 152,4 mm (6 pouces) autour de la circonférence interne, en des emplacements décalés, et
(ii) à souder ensuite le reste de la circonférence interne,

(8) à effectuer ensuite un soudage le long de la circonférence externe de la cloison de séparation (58), cette étape comportant les étapes consistant

(i) à effectuer un soudage de bandes allant d'environ 101,6 mm (4 pouces) à 152,4 mm (6 pouces) autour de la circonférence exter-

ne, en des emplacements décalés, et
(ii) à souder ensuite le reste de la circonférence externe,

(9) à rétablir la relation prédéterminée entre la cloison de séparation (58) et les pattes de montage (48), cette étape comportant les étapes consistant

(i) à enlever la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion de l'appareil de remise en état (78),
(ii) à placer la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion sur un vérin hydraulique,
(iii) à placer une plaque profilée à l'intérieur de la partie capotée (32a) à cloison de séparation de l'ensemble de chambre de combustion et
(iv) à tirer la plaque vers le bas jusqu'à ce que la relation prédéterminée entre la cloison de séparation (58) et les pattes de montage (48) soit rétablie.

16. Procédé de remise en état d'une partie capotée à cloison de séparation d'un ensemble de chambre de combustion suivant la revendication 1 caractérisé en ce que l'ensemble de chambre de combustion (32) comporte en outre une paroi interne (42) espacée relativement en avant de la paroi externe (44) et s'étendant sensiblement parallèlement à la paroi externe (44), et le procédé de remise en état comporte l'étape de séparation de la paroi interne (42) à partir de l'ensemble de chambre de combustion.

17. Ensemble de chambre de combustion remis en état par le procédé suivant l'une quelconque des revendications 1 à 16.

fig.1

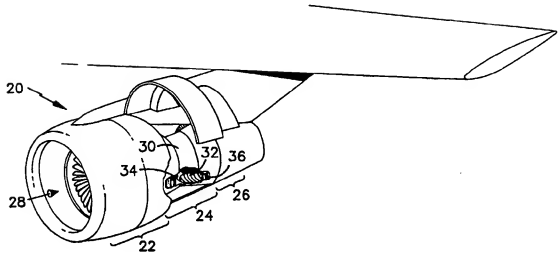


fig3

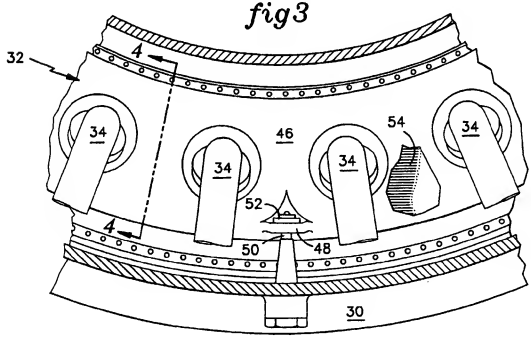


fig.2

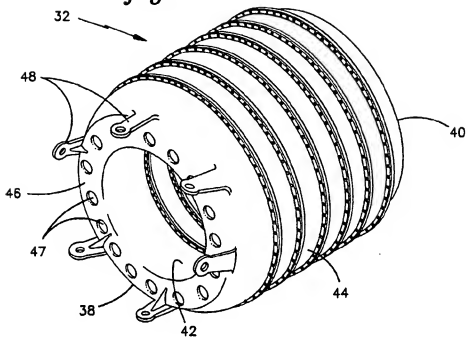

32
48
40
46
47
44
38
42

fig.4

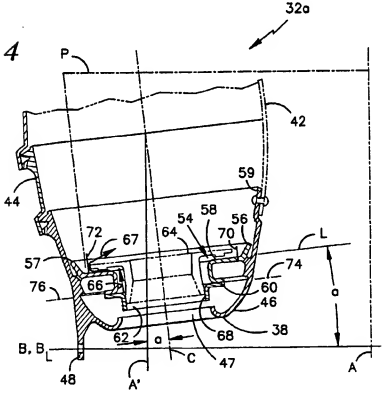

32a
P
42
59
44
58
54
56
72
67
64
70
L
57
74
76
66
60
a
46
62
a
68
38
B, B
L
48
A'
C
47
A

fig.5

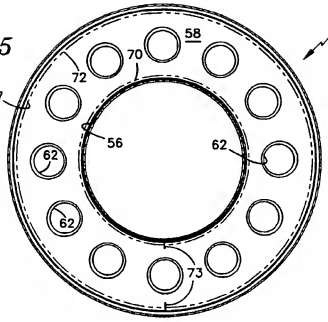

54
58
70
72
57
56
62
62
62
73

fig.6

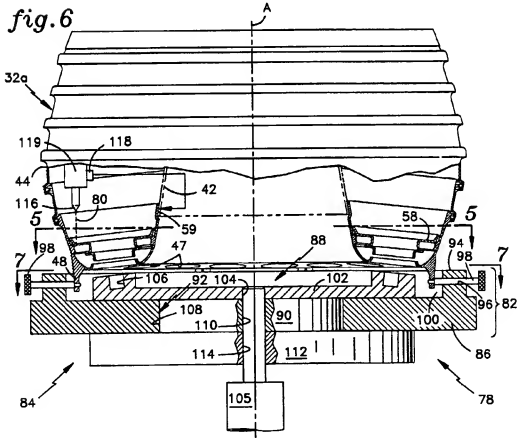

A
32a
119
118
44
42
116
80
5
59
58
5
98
47
88
94
98
7
48
7
106
92
104
102
96
82
108
90
100
110
86
114
112
84
78
105

fig.7

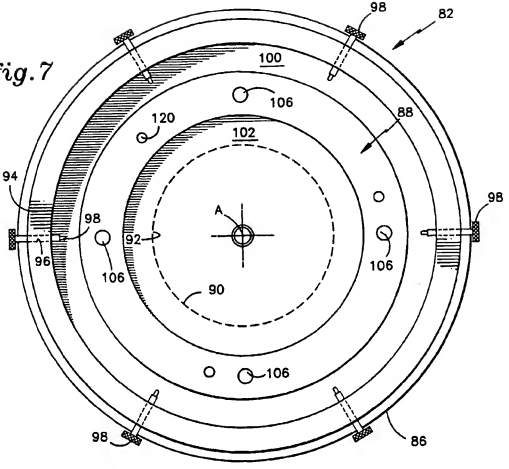
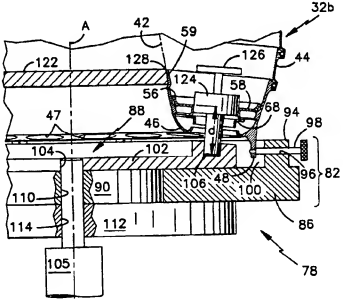

98
82
100
106
120
88
102
94
98
A
92
96
106
106
90
106
98
86

fig.8


32b
A
42
59
122
128
126
44
124
58
56
68
47
88
94
98
46
104
102
96
82
106
48
100
90
110
86
114
112
105
78